SOIL ASSOCIATIONS AND LAND CLASSIFICATION FOR IRRIGATION, SAN JUAN COUNTY

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SOIL ASSOCIATIONS AND LAND CLASSIFICATION FOR IRRIGATION, SAN JUAN COUNTY

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This report presents information on the suitability of soils in San Juan County for irrigation. The acreage, general location, and relative capability of the soils for such use are given. This information can be used in appraising the value or suitability of large tracts of land for irrigation. For operators on irrigated land to obtain a satisfactory income, it is essential that only soils capable of supporting sustained irrigation be developed for this use. Obviously, limited or expensive irrigation water should be used on soils that are the most productive and have the fewest limitations. The general soil map of San Juan County provided the information needed in making the estimates on the extent and location of soils in the various irrigation land classes. These land classes provide a relative rating on the suitability of land for irrigation. For example, Class 1 land has few or no limitations for irrigation; Class 4 land has very severe limitations; Class 6 land is non-irrigable. This report also provides information on soil resources that can be used for preliminary planning for forestry, range, urban, engineering, recreation and wildlife uses, as well as for planning the potential development of irrigated land.

Procedures

In this county, the irrigation land classes were estimated on the basis of the soil data available from the general soil map (figure 1). The individual kinds of soils in each soil association were placed into one of five classes of irrigable and non-irrigable land. The standards used for estimation of irrigated land classes are those that have been adopted for river basin planning in the Southwest, by various state and federal agencies concerned with land classification.

General soil areas, or soil associations, of San Juan County are shown on the general soil map. Each area, or map unit, has a distinctive proportional pattern of soils. Since individual kinds of soil normally occur in comparatively small areas, the soil associations on the general soil map of San Juan are usually made up of two or more kinds of soil. In addition, land types and a number of minor soils are commonly components of the map units in this county. The kinds of soil included in each of the soil associations are not necessarily similar. In fact, they are often contrasting in characteristics that influence their use and management.

Although general soil maps are usually made by generalizing from large-scale detailed soil maps, this was possible only to a limited extent in San Juan County. Detailed soil surveys were almost entirely limited to the irrigated lands and contiguous areas of rangeland. The general soil map of this county, therefore, was prepared to a large extent on the basis of a field reconnaissance together with interpretation of airphotos, topographic maps, geological maps, and other available information.

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The general soil map of San Juan County does not replace the need for detailed soil maps for operational planning on individual farms and ranches or the planning of specific locations for houses, roads, parks and other items of this nature. General soil maps as indicated previously are suitable *only* for *general or broad area planning.* They do, however, serve a very useful purpose when available at the proper time in the planning process.

Location and Topography

San Juan County comprises an area of 3,530,200 acres in the extreme northwestern part of New Mexico. Although the general appearance of much of the county is that of a moderately undulating plain, the area is broken by numerous small mesas, hogback ridges, steep outcrops of sedimentary rocks, and a few igneous dikes.

The northeastern part of the county is dominated by steeply sloping, rough, broken lands. It is characterized by a high-relief, stepped topography in which relatively narrow valley floors are separated from upland summits by steep canyon walls. The resistant sandstone formations in this part of the county have formed prominent structural benches, buttes, and mesas bounded by cliffs and escarpments.

A relatively small mountainous area, locally known as the Chuska Mountains, is located in the southwestern part of the county. The topography of this area varies extremely, ranging from nearly level to gently sloping and undulating on the mountain top or plateau to the very steep dissected mountain slopes. The soils in this part of the county are generally developing in materials of sandstone origin.

The central and remaining parts of the county are characterized by broad, gently sloping to rolling plains and valleys with locally prominent outcrops of sandstone and shale, mesas, buttes, and hogback ridges. Many of the plains and upland areas to the east of the Chaco River have a cover of alluvial and eolian materials.

Nearly level to gently sloping valley bottoms border many of the principal drainages of the county. These occur in the entrenched valleys of the San Juan, Animas, and La Plata rivers as well as in a number of the smaller ephemeral stream systems.

The area is drained by the San Juan River which originates in Colorado and re-enters that state after making a loop through the northern part of San Juan County. In addition to the San Juan River, including the Animas, La Plata, and Los Pinos tributaries, this county contains numerous intermittent drainageways. The Chaco River, the largest of these intermittent streams, generally flows northwesterly from the southeastern part of the county to its confluence with the San Juan River just east of Shiprock. Many of the intermittent streams are bordered by highly erodible soils and barren or nearly barren shale hills. During periods of flash floods, these streams contribute considerable sediment to the drainage system.

Shiprock, in the northwest part of the county, has an elevation of 4,945 feet. From this point, the general land level increases to the north, east, and south to a maximum of slightly over 9,300 feet in the Chuska Mountains in the southwestern part of the county. Elevations of 6,800 feet to slightly more than 7,100 feet are common near the east county boundary and in the northeastern part near the Colorado-New Mexico state line.

Climate[3]

Distant high mountains shield San Juan County from much precipitation that would otherwise occur and from shallow intrusions of extremely cold air in winter. Aridity is maintained because the air from the Gulf of Mexico loses most of its moisture before it reaches northwestern New Mexico, and much of the moisture in air from over the Pacific is removed by the high western mountains over which it flows.

Average annual precipitation totals from 5 to 8 inches along the valley, generally increasing with increasing elevation to nearly 12 inches along the Colorado border and to more than 15 inches in the mountains of the southwest corner. Annual amounts may vary greatly, as shown by totals ranging from 3 inches to as much as 24 inches at Aztec Ruins National Monument area. Monthly precipitation is greatest in late summer and early fall when thunderstorms, occasionally accompanied by hail, are most active. Winter precipitation is heavier than fall or spring precipitation.

The snowfall season is November through April with annual totals averaging from 9 inches in the valley to more than 20 inches along the Colorado border and high elevations. Snowfall in the Colorado Mountains is the primary source of

[3]This section was prepared by Frank E. Houghton, ESSA, Weather Bureau State Climatologist.

Table 1. Monthly temperatures and precipitation, Aztec Ruins National Monument, San Juan County, New Mexico, 1931-1960, elevation 5640 feet

Item	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperatures (F°)												
Average daily maximum	43	49	58	68	77	86	91	88	82	70	55	45
Average daily minimum	15	20	25	32	41	48	57	56	48	37	23	17
Daily mean	29	34	41	50	59	67	74	72	65	54	39	31
Extreme maximum	66	78	80	89	95	103	104	105	96	87	80	67
Extreme minimum	-22	-27	1	10	21	31	43	41	29	13	-7	-16
Precipitation												
Average (inches)	.74	.76	.79	.60	.67	.44	.94	1.32	1.12	1.09	.49	.86
Average days 0.10 inch or more (no.)	3	3	3	2	2	1	3	4	3	3	2	3
Average snowfall (inches)	6.7	4.8	2.0	0.5	T	T	0	0	T	0.1	1.8	5.7

T = Trace, amount too small to measure.

Table 2. Annual averages of selected climatological data, San Juan County, New Mexico, for period of record through 1960

Station	Elevation	Temperatures: Mean maximum	Temperatures: Mean minimum	Temperatures: Yrs. of record	Precipitation: Mean annual	Precipitation: Yrs. of record	Last 32° F or Lower in Spring	First 32° F or Lower in Fall	Time Between Dates
	feet	° F	° F	no.	in.	no.	- - average date - -		days
Aztec Ruins National Monument	5640	68	35	30	9.33	59	May 12	Oct. 9	150
Bloomfield 3SE[1]	5794	68	35	51	8.46	60	May 8	Oct. 9	154
Chaco Canyon National Monument	6125	68	34	25	8.67	28	May 22	Oct. 8	139
Farmington 4NE[1]	5395	68	35	20	8.22	46	May 14	Oct. 7	146
Farmington Airport	5495	67	37	19	8.12	20	May 4	Oct. 21	170
Fruitland	5165	69	36	47	6.96	55	May 11	Oct. 7	149
Newcomb	5565	70	35	11	5.35	13	May 10	Oct. 12	155
Shiprock 1E[1]	4974	70	37	29	7.04	32	May 1	Oct. 15	167
Whiskey Creek	7450				14.97	12			

[1]Figures and letters following the station name, such as 3SE, indicate distance in miles and direction from the postoffice.

summer irrigation water along the San Juan River. Temperatures rarely reach 100 degrees Fahrenheit, and only a few days a year have temperatures of zero or below. Average annual temperature is in the low fifties. The average daily range of temperature is nearly 33 degrees, so frequent freezing and thawing of the surface takes place in December through March when night-time temperatures average below freezing. Extremes of temperature in the county have been 110 degrees at Fruitland and -35 degees at Bloomfield.

The period between the last freezing or lower temperature in the spring, and the first in the fall ranges from 139 days at Chaco Canyon National Monument to 170 days at the Farmington airport. The monthly pattern of temperature and precipitation in the county is illustrated in table 1 with data from Aztec Ruins National Mounment. This pattern is generally applicable to other localities within the county, for which selected annual averages are listed in table 2.

Evaporation for May through October, as measured by a Class A pan, averages 49 inches at Farmington, but may be as much as 25% greater at higher plateau locations where there is greater wind movement.

Sunshine occurs about 70% of the possible number of hours. Average relative humidity is nearly 50%, ranging from 70% in early morning hours to 30% in the afternoons. In late spring and early summer, afternoon relative humidities are more nearly 15 to 20%.

The two predominant directions of winds in the valley are from the east and west, influenced by orientation of the valley. Strong winds are most common from the west. Spring is the windiest season with an average of 10 miles per hour. Winds of 25 miles per hour or greater occur only 1% of the time, but they occasionally cause blowing dust when the soil is dry.

Land Use

Although only a small percentage of the land area in San Juan County is farmed under irrigation,

this agricultural enterprise contributes much to the county's economy. The present irrigation farming is largely confined to the valleys of the San Juan, Animas, and La Plata rivers. It was estimated by the State Conservation Needs Committee that approximately 49,000[4] acres of land were irrigated in 1966. Urban and industrial expansion during recent years has withdrawn some of the prime agricultural land. New lands have been brought under irrigation to replace that withdrawn for other uses; hence, there has been little or no change in total irrigated land in recent years. Alfalfa and corn are the most extensively grown crops: lesser acreages of tree fruits, small grains, beans, vegetables, and potatoes are grown, but any one of them may be the main cash crop in a particular area.

The Navajo Irrigation Project, a project authorized for construction by the Bureau of Reclamation, will provide irrigation water for approximately 110,000 acres of additional land in this county when the project is completed.

Ranching is the principal agricultural enterprise on the non-irrigated lands. In 1967, the county's rangeland supported about 17,800 cattle and 142,100 sheep.[5]

The use of land for wildlife and recreational purposes is also of considerable importance in San Juan County. Two national monuments, Aztec Ruins and Chaco Canyon, in the county are managed by the National Park Service. Fishing and recreational facilities are available at Navajo Reservoir, Morgan Lake, and the Animas and San Juan rivers.

Description of Soils[6]

There are 18 soil associations on the general soil map for San Juan County. The soils in each are geographically associated. Each soil association is named for its major soil series and land type. Where the soil series was not known, a descriptive title was used to identify the mapping unit. Selected soil characteristics and qualities of major soils in each soil association are summarized in table 3. A description of each soil association follows.

1. Persayo Association

This association occurs mainly on undulating to hilly areas in northwestern San Juan County. The soils, which are dominantly calcareous and shallow, are developing in material weathered from shale and sandstone. Exposures of shale and sandstone are common in the hilly parts. Approximately eight percent of San Juan County is included in this association.

Soil Characteristics. Persayo soils, the most extensive in the association, are developing on upland slopes and ridges in a thin layer of calcareous material weathered from the underlying shale. They have a thin surface layer of pale yellow or light yellowish-brown granular silty clay loam. This is underlain by a light yellowish-brown or pale yellow silty clay loam subsoil that typically contains a moderate amount of partly weathered shale fragments. Concretions of calcium carbonate and crystals of calcium sulfate are also common throughout the subsoil and substratum. The depth to shale ranges from about 6 to 18 inches.

Moenkopie soils, which are shallow over sandstone, are also relatively extensive in this mapping unit. They have a surface layer of pale brown to yellowish-brown, calcareous sandy loam. This is underlain by sandy loam or loamy fine sand that often contains a few angular fragments of sandstone gravels and cobbles. Sandstone bedrock is typically encountered at depths ranging from about 10 to 18 inches.

In addition to the two principal soils, miscellaneous land types and soils of minor extent comprise approximately 30 percent of the association. The land types include Sandstone Rockland, Gypland, and Badland. These occupy the very steep slopes and breaks and are characterized by outcrops of bedrock. Soils of the Shiprock series and an associated deep loamy sand soil are also important in this unit. The Shiprock soils have a surface layer of fine sandy loam, over a thin sandy clay loam subsoil. This is underlain by loamy fine sand or sandy loam. Alluvial soils in the narrow valley bottoms and swales contiguous to intermittent drainages also comprise a small acreage in this unit. These soils are deep and generally medium to moderately fine-textured.

[4] Sorenson, E. F. and Allison, D. V. Irrigation in New Mexico in 1966 as indicated by Conservation Needs Inventory, State Engineers Office. 1968.

[5] New Mexico Agricultural Statistics, Vol. VI–Supplement 1. 1968.

[6] Soil series names used to identify mapping units in this report are subject to change; however, all have been used similarly in other areas. Where no approved name was known to exist a descriptive title has been used in this report to identify the mapping unit.

Present Land Use. The soils of this association are used largely for grazing of livestock and wildlife. They provide only limited grazing as they support a sparse cover of native grasses and shrubs. The principal grasses include galleta, Indian rice grass, and blue grama. Pinyon, juniper, serviceberry, bitterbrush, saltbrush, shadscale, and snakeweed represent the more common shrubs and woody species. Due to the sparse vegetative cover and low intake rate of many of the soils, runoff is high and erosion hazard moderate to severe.

Irrigation Potential. There is very little potential for the development of irrigated cropland in this unit because of steep slopes or hilly topography and unfavorable soil properties. All soils and land types in this association are in Class 6, except those of the Shiprock and Sundown series, which are in irrigation land classes 2 and 4, respectively. They occur in small isolated tracts and are of limited extent.

2. San Mateo-Fruitland-Woodrow Association

This association includes the soils of the entrenched valleys of the San Juan, La Plata, Animas, Los Pinos rivers, as well as a number of smaller, intermittent drainage systems. They are nearly level to gently sloping and dominantly deep. These soils, which are forming in stratified alluvium of mixed origin, comprise approximately eight percent of the land area in the county.

Soil Characteristics. The San Mateo soils, one of the more extensive soils in the association, occur on level to very gently sloping flood plains of the principal drainages. They have a surface layer of grayish-brown or pale brown loam. This is underlain to a depth of five feet or more by stratified loams and sandy loams.

Woodrow soils have a thick surface layer of grayish-brown loam or clay loam over a slowly permeable silty clay loam subsoil. The substratum is typically stratified and medium to moderately fine-textured. They occur on nearly level to very gently sloping flood plains and alluvial valley bottoms.

Fruitland soils usually occur on gently sloping alluvial fans and piedmont slopes. They typically have pale brown, calcareous sandy loam surface layers and a pale brown or light yellowish-brown calcareous sandy loam subsoil. To a depth of five feet or more, the underlying material is similar in color and texture to the surface horizons, and may be weakly stratified.

Other soils of importance in this unit include a number of unclassified soils, as well as those of the Turley, Genola, Christianburg, and Sundown series. The Turley soils occur on gently sloping alluvial fans and on nearly level flood plains adjacent to ephemeral streams. They are deep, calcareous, light brownish-gray to light yellowish-brown, clay loam or silty clay loam soils. The Genola soils occur in association with those of the Turley series. They differ principally from those of the Turley series in texture and permeability. The Genola soils are moderately permeable and have very fine sandy loam, loam, or silt loam profiles. The Christianburg soils, which are deep, include those with profiles of clay texture. They are typically strongly calcareous and usually contain some gypsum and soluble salts. They occur on nearly level fans and flood plains adjacent to ephemeral streams. Sundown soils commonly occupy gently to strongly sloping alluvial fans below escarpments or breaks. These deep, light brownish-gray soils have profiles of loamy sand or loamy fine sand. Soils shallow over gravel and cobble also occur to a limited extent on the flood plains of the principal drainages. Saline and wet phases of Woodrow and San Mateo soils also occur to a limited extent.

Miscellaneous land types such as gullied land, riverwash, and marshland comprise about 15 percent of this association.

Present Land Use. The 49,000 acres of irrigated land in San Juan County is essentially all in this association. Although a wide variety of crops is grown, alfalfa and corn are the most extensive. Other crops of importance include tree fruits, small grains, vegetables, and potatoes. In addition to the irrigated land, a considerable acreage of land in this unit is occupied by urban and industrial built-up areas. Although the soils generally have favorable properties for engineering installations, there are included wet and saline soils, as well as soils with moderate to high shrink-swell potential that need to be considered in construction.

The soils not now irrigated or in urban and industrial built-up areas provide limited grazing for livestock and wildlife. Native vegetation includes galleta, Indian ricegrass, sand dropseed, alkali sacaton, salt grass, fourwing saltbrush, and snakeweed. Cottonwood trees and some salt cedar occur on the soils of the floodplains of the major rivers and streams.

Irrigation Potential. The major soils in this association are well suited for use as cropland

Table 3. Soil characteristics and qualities of major soils in each soil association, San Juan County, New Mexico

Soil Map Symbol and Soil Association	Slope (percent)	Percent of Association	Pedologic Classification: Subgroup	Pedologic Classification: Family	Texture[3]
1 Persayo					
Persayo silty clay loam	5-30	40	Typic Torriorthent	Loamy, mixed, calcareous, mesic, shallow	sil;sicl
Moenkopie sandy loam	5-30	30	Lithic Torriorthent	Loamy, mixed, calcareous, mesic	sl;lfs
Sundown loamy sand	1-9	10	Typic Torripsamment	Mixed, mesic	ls;sl
Shiprock fine sandy loam	0-5	5	Typic Haplargid	Coarse-loamy, mixed, mesic	fsl;lfs
Badland	10-75	10			
Rockland	30-75	5			
2 San Mateo-Fruitland-Woodrow					
San Mateo loam	0-2	15	Typic Torrifluvent	Fine-loamy, mixed, calcareous, mesic	Loam;cl
Fruitland sandy loam	0-9	8	Typic Torriorthent	Coarse-loamy, mixed, calcareous, mesic	scl;sl;ls
Woodrow clay loam	0-2	15	Typic Torrifluvent	Fine-silty, mixed, calcareous, mesic	Loam;cl
Turley clay loam	0-5	12	Typic Torriorthent	Fine-loamy, mixed, calcareous, mesic	Loam;cl
Christianburg clay	0-2	5	Typic Torrifluvent	Fine, mixed, calcareous, mesic	sicl;clay
Unnamed 22	0-5	15	Typic Torriorthent	Fine-loamy, mixed, calcareous, mesic	Loam
Sundown loamy sand	1-9	5	Typic Torripsamment	Mixed, mesic	ls;sl
Other soils (unclassified)	-	15			
Miscellaneous land types	-	10			
3 Doak-Shiprock					
Doak loam	0-5	35	Typic Haplargid	Fine-loamy, mixed, mesic	Loam;scl
Shiprock fine sandy loam	0-5	25	Typic Haplargid	Coarse-loamy, mixed, mesic	fsl;lfs
Unnamed 46	0-5	25	Typic Calciorthid	Fine-loamy, mixed, mesic	Loam
Persayo silty clay loam	5-30	5	Typic Torriorthent	Loamy, mixed, calcareous, mesic, shallow	sil;sicl
Other soils (unclassified)	-	7			
Miscellaneous land types	-	3			
4 Shiprock-Sheppard-Nageesi					
Shiprock fine sandy loam	0-5	30	Typic Haplargid	Coarse-loamy, mixed, mesic	fsl;lfs
Sheppard loamy sand	1-15	25	Typic Torripsamment	Mixed, mesic	ls;lfs
Nageesi sandy loam	0-5	20	Typic Calciorthid	Coarse-loamy, mixed, mesic	sl
Persayo silty clay loam	5-30	5	Typic Torriorthent	Loamy, mixed, calcareous, mesic, shallow	sil;sicl
Unnamed B	0-8	15	Typic Camborthid	Coarse-loamy over sandy, mixed, mesic	fsl;lfs
Other soils	-	5			
5 Hilly Gravelly Land					
Hilly gravelly land	5-75	75	Miscellaneous land type		
Doak loam	0-5	4	Typic Haplargid	Fine-loamy, mixed, mesic	Loam;scl
Unnamed 46	0-5	4	Typic Calciorthid	Fine-loamy, mixed, mesic	Loam
Miscellaneous land types	30-75	12			
Other soils	-	5			
6 Badland-Rockland-Alluvial Land					
Badland	0-75	50	Miscellaneous land type		
Rockland	-	20	Miscellaneous land type		
Alluvial land	1-9	15	Miscellaneous land type		
Persayo silty clay loam	5-30	5	Typic Torriorthent	Loamy, mixed, calcareous, mesic, shallow	sil;sicl
Other soils and land types	-	10			
7 Turley-Badland					
Turley clay loam	0-5	35	Typic Torriorthent	Fine-loamy, mixed, calcareous, mesic	Loam;cl
Moenkopie sandy loam	5-30	20	Lithic Torriorthent	Loamy, mixed, calcareous, mesic	sl;lfs
Badland	30-75	20	Miscellaneous land type		
Unnamed 22	0-5	10	Typic Torriorthent	Fine-loamy, mixed, calcareous, mesic	Loam
Other soils	-	10			
Other miscellaneous land types	-	5			
8 Rockland-Billings					
Rockland	30-75	60	Miscellaneous land type		
Billings silty clay loam	0-5	15	Typic Torrifluvent	Fine-silty, mixed, calcareous, mesic	sil;sicl
Christianburg clay	0-3	10	Typic Torrifluvent	Fine, mixed, calcareous, mesic	sicl;clay
Moenkopie sandy loam	3-30	10	Lithic Torriorthent	Loamy, mixed, calcareous, mesic	sl;lfs
Other soils	-	5			

[1]Depth of effective soil material

[2]AWHC-Available water holding capacity (estimated to a depth of 4 feet or to bedrock if less than 4feet)

[3]Abbreviations used for textural classes are.
ls-loamy sand
lfs-loamy fine sand
sl-sandy loam
fsl-fine sandy loam
vfsl-very fine sandy loam
sil-silt loam
scl-sandy clay loam
cl-clay loam
sicl-silty clay loam

Surface Soil Features		Subsoil Features				Soil Depth[1]	AWHC[2]
Color	Carbonates[4]	Texture[3]	Color	Permeability[5]	Substratum	(inches)	(inches)
Pale yellow	Strongly calc.	sicl	Light yellowish-brown	Slow	Shale	8 to 20	1 to 3
Pale brown	Weakly calc.	sl	Very pale brown	Rapid	Sandstone	10 to 20	1 to 2
Light brownish-gray	Weakly calc.	ls	Light brownish-gray	Very rapid	Sandy alluvium	60 or more	3 to 4
Light brown	Non-calc.	scl;fsl	Reddish brown	Moderate	Sandy eolian sediments	60 or more	5 to 6
Grayish brown	Calc.	Loam;scl;vfsl	Grayish-brown	Moderate	Loamy alluvium	60 or more	7
Pale brown	Calc.	sl	Yellowish brown	Rapid	Sandy alluvium	60 or more	5
Grayish brown	Calc.	cl;sicl	Light yellowish-brown	Slow	Loamy alluvium	60 or more	8
Light brownish-gray	Calc.	cl	Light brownish-gray	Slow	Loamy alluvium	60 or more	8
Light brownish-gray	Calc.	Clay	Light brownish-gray	Very slow	Clayey alluvium	60 or more	7
Light olive brown	Calc.	Loam	Olive brown	Moderate	Loamy alluvium	60 or more	7
Light brownish-gray	Weakly calc.	ls;sand	Light brownish-gray	Very rapid	Sandy alluvium	60 or more	3 to 4
Brown	Non-calc.	cl	Brown	Moderate	Loamy alluvium	60 or more	8
Light brown	Non-calc.	sol	Reddish-brown	Moderate	Sandy eolian sediments	60 or more	5 to 6
Brown	Strongly calc.	Loam;cl	Light brown	Moderate	Strongly calc. loams	60 or more	6
Pale yellow	Strongly calc.	sicl	Light yellowish-brown	Slow	Shale	8 to 20	1 to 3
Light brown	Non-calc.	sol	Reddish-brown	Moderate	Sandy eolian sediments	60 or more	5 to 6
Pale brown	Weakly calc.	ls	Very pale brown	Rapid	Sandy eolian sediments	60 or more	3 to 4
Reddish-yellow	Strongly calc.	sl	Reddish-yellow; white	Moderate	Strongly calc. sandy loam	24 to 36	4
Pale yellow	Strongly calc.	sicl	Light yellowish-brown	Slow	Shale	8 to 20	2 to 3
Light brown	Non-calc.	sol;sand	Light reddish-brown	Rapid	Sandy eolian sediments	60 or more	3
Brown	Non-calc.	cl	Brown	Moderate	Loamy alluvium	60 or more	8
Brown	Strongly calc.	Loam;cl	Light brown	Moderate	Strongly calc. loams	60 or more	6
Pale yellow	Strongly calc.	sicl	Light yellowish-brown	Slow	Shale	8 to 20	2 to 3
Light brownish-gray	Calc.	cl	Light brownish-gray	Slow	Loamy alluvium	60 or more	8
Pale brown	Weakly calc.	sl	Very pale brown	Rapid	Sandstone	10 to 20	1 to 2
Light olive brown	Calc.	Loam	Olive brown	Moderate	Loamy alluvium	60 or more	7
Light gray	Calc.	sicl	Light brownish-gray	Slow	Loamy alluvium	60 or more	8
Light brownish-gray	Calc.	Clay	Light brownish-gray	Very slow	Clayey alluvium	60 or more	7
Pale brown	Weakly calc.	sl	Very pale brown	Rapid	Sandstone	10 to 20	1 to 2

[4]Other abbreviations
calc. -calcareous

[5]Five classes of soil permeability used are:

	Possible rates in inches per hour		Possible rates in inches per hour
Very slow	Less than 0.2	Rapid	2.5 to 6.0
Slow	0.2 to 0.6	Very rapid	Over 6.0
Moderate	0.6 to 2.5		

Table 3. Continued

Soil Map Symbol and Soil Association	Slope (percent)	Percent of Association	Pedologic Classification: Subgroup	Family	Texture
9 Moenkopie					
Moenkopie sandy loam	3-30	30	Lithic Torriorthent	Loamy, mixed, calcareous, mesic	fsl;lfs
Unnamed 62	1-9	50	Typic Camborthid	Coarse-loamy, mixed, calcareous, mesic	fsl;vfsl
Unnamed 63	1-5	10	Typic Camborthid	Coarse-loamy, mixed, calcareous, mesic	fsl;vfsl
Other soils	-	5			
Miscellaneous land types	-	5			
10 Persayo-Billings					
Persayo silty clay	0-15	60	Typic Torriorthent	Loamy, mixed, calcareous, mesic, shallow	sil;sicl
Billings silty clay loam	0-5	26	Typic Torrifluvent	Fine-silty, mixed, calcareous, mesic	sil;sicl
Christianburg clay	0-3	3	Typic Torrifluvent	Fine, mixed, calcareous, mesic	sicl;clay
Other soils	-	7			
Miscellaneous land types	-	4			
11 Persayo-Rockland					
Persayo silty clay loam	1-15	40	Typic Torriorthent	Loamy, mixed. calcareous, mesic, shallow	sil;sicl
Unnamed 62	1-8	20	Typic Camborthid	Coarse-loamy, mixed. calcareous, mesic	fsl;vfsl
Rockland	30-75	20			
Other soils	-	10			
Other miscellaneous land types	-	10			
12 Chipeta-Sheppard-Shiprock					
Chipeta clay	0-15	58	Typic Torriorthent	Clayey, mixed, calcareous, mesic, shallow	sicl;clay
Sheppard loamy sand	1-9	17	Typic Torripsamment	Mixed, mesic	ls;lfs
Shiprock fine sandy loam	0-5	10	Typic Haplargid	Coarse-loamy, mixed, mesic	fs;lfs
Miscellaneous land types	-	10			
Other soils	-	5			
13 Rockland-Shallow Soil					
Rockland	30-75	45	Miscellaneous and type		
Unnamed 101	3-30	35	Lithic Torriorthent	Loamy, mixed, calcareous, mesic	Loam
Other soils	-	10			
Other miscellaneous land types	-	10			
14 Travessilla-Rockland					
Travessilla sandy loam	3-30	40	Lithic Ustic Torriorthent	Loamy, mixed. calcareous, mesic	sl
Rockland	30-75	25	Miscellaneous and type		
Del Rio loam	1-9	8	Ustollic Haplargid	Fine-silty, mixed, mesic	Loam;sil
Unnamed 111	3-30	10	Ustic Torriorthent	Loamy, mixed, calcareous, mesic, shallow	cl;sicl
Other soils	-	7			
Other miscellaneous land types	-	10			
15 Del Rio-Caja					
Del Rio loam	1-9	45	Ustollic Haplargid	Fine-silty, mixed, mesic	Loam;sil
Caja loam	0-5	30	Ustollic Haplargid	Fine, mixed, mesic	Loam;sil
Travesilla sandy loam	3-30	10	Lithic Ustic Torriorthent	Loamy, mixed, calcareous, mesic	sl
Other soils	-	10			
Miscellaneous land types	-	5			
16 La Fonda-Del Rio					
La Fonda loam	1-9	50	Ustollic Camborthid	Fine-loamy, mixed, mesic	Loam
Del Rio loam	9-30	30	Jstollic Haplargid	Fine-silty, mixed, mesic	Loam;sil
Rockland	-	10			
Other soils	-	10			
17 Travessilla-Malposa-Rockland					
Travessilla sandy loam	5-30	30	Lithic Ustic Torriorthent	Loamy, mixed, calcareous, mesic	sl
Malposa loam	5-30	30	Ustollic Haplargid	Fine-loamy, mixed, mesic	Loam
Rockland	-	25			
Other soils	-	15			
18 Mountain Soils					
Unnamed 201	5-75	35	Typic Eutroboralf	Fine-loamy, mixed	Loam
Unnamed 203	3-30	20	Lithic Haploboroll	Loamy, mixed	fsl;loam
Unnamed 202	0-9	10	Typic Eutroboralf	Fine-lo ny, mixed	Loam
Rockland	30-75	20			
Other soils	-	15			

[1]Depth of effective soil material

[2]AWHC-Available water holding capacity (estimated to a depth of 4 feet or to bedrock if less than 4 feet)

[3]Abbreviations used for textural classes are:
ls-loamy sand
lfs-loamy fine sand
sl-sandy loam
fsl-fine sandy loam
vfsl-very fine sandy loam
sil-silt loam
scl-sandy clay loam
cl-clay loam
sicl-silty clay loam

Surface Soil Features		Subsoil Features				Soil Depth[1]	ASHC[2]
Color	Carbonates[4]	Texture[3]	Color	Permeability[5]	Substratum	(inches)	(inches)
Light brown	Weakly calc.	sl	Very pale brown	Rapid	Sandstone	10 to 20	1 to 2
Light brown	Weakly calc.	fsl;vfsl	Light brown	Moderate	Sandstone	20 to 36	3 to 4
Light brown	Weakly calc.	vfsl;fsl	Light brown	Moderate	Fine sandy loam	60 or more	6
Pale yellow	Calc.	sicl	Light yellowish-brown	Slow	Shale	6 to 20	2 to 3
Light gray	Calc.	sicl	Light brownish-gray	Slow	Loamy alluvium	60 or more	8
Light brownish-gray	Calc.	Clay	Light brownish-gray	Very slow	Clayey alluvium	60 or more	7
Pale yellow	Calc.	sicl	Light yellowish-brown	Slow	Shale	6 to 20	2 to 3
Light brown	Weakly calc.	fsl;vfsl	Light brown	Moderate	Sandstone	20 to 36	3 to 4
Light yellowish-brown	Strongly calc.	Clay	Light yellowish-brown	Very slow	Shale	10 to 20	2 to 3
Pale brown	Weakly calc.	ls	Very pale brown	Very rapid	Sandy eolian sediments	60 or more	3 to 4
Light brown	Non-calc.	scl	Reddish-brown	Moderate	Eolian sediments	60 or more	5 to 6
Light brown	Calc.	Loam;cl	Pale brown	Moderate	Sandstone	10 to 20	2 to 3
Light brownish-gray	Weakly calc.	sl	Pale brown	Rapid	Sandstone	10 to 20	1 to 2
Brown	Non-calc.	cl;sicl	Reddish-brown	Mod. to slow	Loamy eolian	60 or more	8
Grayish-brown	Calc.	cl;sicl	Grayish-brown	Slow	Shale	10 to 20	2 to 3
Brown	Non-calc.	sicl;cl	Reddish-brown	Mod. to slow	Loamy eolian	60 or more	8
Brown	Non-calc.	Clay;sicl	Grayish-brown	Slow	Loamy eolian	60 or more	8
Light brownish-gray	Weakly calc.	sl	Pale brown	Rapid	Sandstone	10 to 20	1 to 2
Reddish-brown	Non-calc.	Loam;cl	Light reddish-brown	Moderate	Loamy alluvium	60 or more	7
Brown	Non-calc.	cl;sicl	Reddish-brown	Slow	Loam and clay loam	60 or more	8
Light brown	Weakly calc.	sl	Pale brown	Rapid	Sandstone	10 to 20	1 to 2
Brown	Non-calc.	scl, cl	Brown	Moderate	Strongly calc. loams	60 or more	6
Grayish-brown	Non-calc.	sl;loam	Yellowish-brown	Moderate	Sandy loam	60 or more	7
Very dark gray	Non-calc.	fsl;loam	Brown	Moderate	Sandstone	10 to 24	1 to 3
Very dark brown	Non-calc.	Loam;scl	Brown	Moderate	Sandy clay loam	60 or more	7

[4]Other abbreviations
calc. -calcareous

[5]Five classes of soil permeability used are:

	Possible rates in inches per hour		Possible rates in inches per hour
Very slow	Less than 0.2	Rapid	2.5 to 6.0
Slow	0.2 to 0.6	Very rapid	Over 6.0
Moderate	0.6 to 2.5		

under irrigation. Approximately 40 percent of the land in this unit is in land class 1, 35 percent in class 2, 5 percent in class 3, and 10 percent in class 4. On the basis of soils there is considerable opportunity for expansion of irrigated land in this association. These soils are, however, widely distributed throughout the county and often occur in relatively small tracts. The shape, size, and location of many of these potentially irrigable soil areas may, therefore, preclude their use for irrigation because of high development costs.

3. Doak-Shiprock Association

The soils of this association occupy the gently sloping tops of elevated benches or mesas in the northern and southeastern parts of the county. The soils have formed mainly in thick alluvial deposits on ancient stream terraces or alluvial fans. Past geologic erosion has worn away much of the original landscape, so that the soils of this unit now occur on elevated mesas that are as much as 100 to 300 feet above the stream channels. This association comprises about five percent of the land area in San Juan County.

Soil Characteristics. The Doak soils, the most extensive in the association, occur on nearly level or in slight depressional areas. These soils have a thin surface layer of light brown or brown, noncalcareous loam. Their subsoil is a brown clay loam that usually contains a few streaks and soft masses of lime in the lower part. This is underlain by a light brown sandy clay loam or clay loam with visible calcium carbonate occurring in finely divided forms and as thin seams and streaks.

The Shiprock soils occur on the gentle slopes just above those of the Doak series. They have a thin surface layer of light brown or light reddish-brown, noncalcareous fine sandy loam. Their subsoil is a brown to reddish-brown noncalcareous, sandy clay loam. This horizon typically extends to a depth of 15 to 20 inches. The substratum is a reddish-brown to reddish-yellow calcareous sandy loam or loamy fine sand. A few fine filaments and small soft masses of lime are usually present in the upper part of this horizon.

Associated with the named soils of this association is a very calcareous soil characterized by a moderate to strong lime zone at depths of 12 to 18 inches. A sandy loam with weak accumulations of lime is usually encountered at depths of three to four feet. This horizon may also contain a few gravels and cobbles.

The remaining 12 to 20 percent of this association consists of hilly-gravelly land and shallow soils over shale, sandstone, or gravel and cobble.

Present Land Use. The soils of this association are used principally for grazing of livestock. Fair yields of forage are obtained under good management. Native vegetation includes galleta, Indian ricegrass, blue grama, sagebrush, snakeweed, and a number of annuals.

Irrigation Potential. The major soils in this association are deep, low in salts, and, if properly managed, not highly erodible. These soil properties, together with their moderate to high water-holding capacity, make them well suited to irrigation. Approximately 85 percent of the land in this association is in class 2, hence there is opportunity for expansion of irrigation when tracts are of sufficient size and so located that irrigation water can be made available feasibly.

4. Shiprock-Sheppard-Nageesi Association

This association comprises the gently sloping to gently rolling upland areas south and east of San Juan and Chaco rivers, respectively. The soils, which are dominantly sandy and deep, are developing in sandy alluvial and eolian deposits. These deposits, in turn, are underlain by sedimentary rocks. Although some of the underlying shales have relatively low permeabilities, the alluvium and eolian materials are generally thick enough to permit adequate subsurface drainage. With the exception of the area immediately to the west of Gallegos Canyon, the ground surface generally slopes to the west and southwest. This unit includes about 352,000 acres, or 10 percent of San Juan County.

Soil Characteristics. The Shiprock soils usually occur on the nearly level to gently sloping part of the area occupied by the soils of this association. They have a thin surface layer of light brown or light reddish-brown noncalcareous fine sandy loam. Their subsoil is a brown to reddish-brown noncalcareous sandy clay loam. This horizon typically extends to a depth of 15 to 20 inches. The substratum is a reddish-brown to reddish-yellow calcareous sandy loam or loamy fine sand. A few fine streaks and small soft masses of lime are usually present in the upper part of the substratum.

The Sheppard soils, in this association, occupy the gently rolling or dunelike areas. The

ridges and dunes are oriented in the direction of the prevailing winds, or in a southwest to northeast direction. They have surface layers of loose, weakly calcareous pale brown or light reddish-brown loamy fine sand. This is underlain by a moderately calcareous sand, fine sand, or loamy sand to a depth of five feet or more.

Nageesi soils usually occur on the gentle slopes in close association with the Shiprock soils. Nageesi soils are characterized by their calcareous surface soils and pinkish-white lime zones at shallow to moderate depths. They usually have moderately thick surface layers of light brown or reddish-yellow sandy loam. The lower part is typically more limy than the upper part. This layer grades through a pale brown sandy loam to very limy pinkish-white loam at depths ranging from 18 to 24 inches.

In addition to the major soils in this association, miscellaneous land types and shallow soils comprise approximately 10 percent of the unit. These soils provide limited grazing, but offer very little potential for the development of irrigated land.

Present Land Use. The soils of this association, which at present are used principally for the grazing of livestock, in general, support a moderately dense cover of vegetation. Under good management moderate yields of forage are obtained. Native vegetation includes galleta, blue grama, Indian ricegrass, sand dropseed, poverty three-awn, snakeweed, big sagebrush, common winterfat, and long-leaf ephedra.

Irrigation Potential. The association comprises the major portion of the land to be irrigated under the Navajo Irrigation Project. Although these soils do have some limitations, their properties in general make them suitable for use as cropland under irrigation. Shiprock soils and soils with similar characteristics comprise about 30 percent of the land in this association. These soils, which are in class 2, have moderate water-holding capacities and permeabilities. The Nageesi soils, which comprise about 20 percent of this unit, were placed in class 3, due primarily to their shallow to moderate depths to massive strong lime zones and to their moderate water-holding capacities. Sheppard soils and closely related sandy soils which comprise approximately 40% of this association were placed in land class 4. These soils have a high rate of water intake, rapid permeability, and low water-holding capacities. Of these, the limiting factor is the water-holding capacity, which is nearly adequate for class 3. Wind erosion is a moderate hazard, and careful management will be needed to minimize damage by wind.

5. Hilly-Gravelly Land Association

Included in this association are the steep side slopes or escarpments of old river terraces and mesas. Although there are occasional exposures of sandstone and shale, this unit is characterized by a thin veneer of gravelly alluvium on the surface. In addition to the gravelly alluvium, shallow soils and colluvial material at the base of the mesa escarpments or slopes are common. This unit, which occurs dominantly along the Animas, La Plata, and San Juan rivers, generally forms the divide between the river valley bottoms and the uplands. It is not extensive, as it comprises only about two percent of the county.

Soil Characteristics. Hilly-gravelly land, a miscellaneous land type, is the principal component of this unit. It typically has a thin surface layer of gravelly loam or cobbly loam. The subsoils are quite variable, ranging from loams that contain very little gravel and cobble, to those that are very gravelly and cobbly. These soils, or soil materials, are usually shallow to gravel and cobble, sandstone, or shale.

Also in this association are the deep, medium-textured Doak soils, a soil shallow over a strong lime zone, and exposures of sandstone and shale.

Present Land Use. Although these soils support only a sparse cover of vegetation, they are not particularly susceptible to serious damage by either wind or water erosion. The numerous gravels and cobbles in the surface layer help to stabilize the soil material.

Under these soils, the percentage of sand and gravel and the thickness of the deposits are quite variable. The thicker deposits offer a potential source for sand and gravel. The principal use of the soils in this unit is for grazing of livestock. They support a fair cover of native grasses, including galleta, blue grama, Indian ricegrass, sand dropseed, three-awn, ring muhly, and western wheat. Sagebrush, snakeweed, rabbit brush, and juniper are some of the more common shrubs.

Irrigation Potential. Hilly-gravelly land is generally not suitable for use as irrigated cropland because of the steep slopes and unfavorable soil properties. The eight percent of class 2 land in this

association is widely distributed as small areas on mesa tops and alluvial side slopes. Due to problems inherent in transporting irrigation water to these small isolated tracts of class 2 land, there is little, if any, opportunity for expansion of irrigated land in the areas occupied by this association.

6. Badland-Rockland-Alluvial Association

This association, the largest in San Juan County, includes an area of about 511,900 acres, or 15 percent of the county. Surface relief ranges from nearly level in the narrow alluvial valley bottoms, through rolling hills, to very steep slopes on escarpments and breaks. It is widely dispersed throughout the county where exposures of shale and sandstone are prevalent. The barren or nearly barren outcrops of shale and sandstone are a characteristic feature of this association.

Soil Characteristics. Badland, the most extensive of the miscellaneous land types comprising this unit, consists of barren or nearly barren outcrops of shale. It is forming primarily in soft shale that is in various stages of weathering. The landscape is one of rolling hills, separated by very narrow valleys or numerous intermittent drainage channels. Due to the low intake rates and very slow permeability, a large amount of water runs off after a normal rain and flash floods follow heavy rains. Seepage and the movement of moisture through the shale materials often cause soluble salts to concentrate in low places and sidehills where seepage water emerges.

Rockland includes escarpments, breaks, and steeply sloping sides of mesas. It is a complex of shallow-soils, sandstone outcrops, and exposures of other types of sedimentary rocks. The sandstone outcrops may appear as vertical exposures or as ledges. A thin mantle of rocky or stony soil material commonly occurs between the ledges or outcrops of bedrock.

Alluvial land includes the moderately deep and deep alluvial soils in the narrow valleys and drainageways within this association. These soils, which are usually stratified and vary widely in texture, commonly receive runoff from adjacent areas.

Also in this association are Moenkopie soils which are shallow over sandstone, the Persayo soils which are shallow over shale, and the deep sandy loam soils of the Shiprock series.

Present Land Use. The land types and soils of this association are used as rangeland. The Badland part of this association supports little vegetation and is of very limited value, even as range. The remaining parts of the association support a sparse cover of native grass, forbs, and brush suitable for grazing by livestock and wildlife. The escarpments, steep slopes, and rock outcrops tend to restrict the movement of livestock in many parts of this unit.

Irrigation Potential. Due to shallow soils, steep slopes, and other unfavorable soil properties, the areas included in this association essentially have no potential for development of irrigated land.

7. Turley-Badland Association

This association includes extensive areas in the southeastern part of San Juan County. It consists of gently sloping, broad, moderately incised valleys, and associated sloping and gently rolling uplands. Deep soils are dominant in the valley bottoms and on the valley slopes, while shallow soils with some outcrops of shale and sandstone are more common in the upland areas. The soils are developing residually in materials of sandstone and shale origin, or in alluvium of similar origin. This association includes about 132,300 acres, or four percent of the land area in San Juan County.

Soil Characteristics. Turley soils, the most extensive in the association, occur dominantly on the gently sloping and undulating valley-filling slopes. They have a moderately thick surface layer of grayish-brown, calcareous, clay loam. This is underlain to a depth of five feet or more by a light olive brown or pale brown calcareous clay loam.

The Moenkopie soils, which occur on the sloping and gently rolling uplands, are usually shallow over sandstone. They have a surface layer of pale brown calcareous sandy loam. Their subsoil is a very pale brown calcareous loamy sand or sandy loam. This is underlain by sandstone at depths ranging from 10 to 20 inches.

Areas identified as Badland comprise from 15 to 25 percent of this association. It is dominantly in the fringe areas just above the valley-filling slope surfaces, but does occur to a lesser extent throughout the association. It is forming mostly in soft shale that is in various stages of weathering. The landscape is one of rolling hills and very steep escarpments. It consists generally of barren or nearly barren outcrops of shale.

In addition to the soils previously described, approximately 10 to 15 percent of this association

consists of deep sandy and loamy soils. Persayo soils that are shallow over shale, and Rockland, a miscellaneous land type, occur to a minor extent in this unit.

Present Land Use. This association is used mainly as native range. The Badland and Rockland areas of this association are barren or support only a very sparse cover of vegetation. The remainder of the areas support a fair cover of native grasses and shrubs, including galleta, blue grama, alkali sacaton, western wheatgrass, Indian ricegrass, sagebrush, and broom snakeweed. Thin stands of pinyon and juniper also occur on the shallow soil and the steeply sloping areas.

Irrigation Potential. The Turley soils and associated deep sandy and loamy soils have properties suitable for use as cropland under irrigation. Approximately 45 percent of this association is in irrigation land class 2, 3 percent in class 4, and the remainder in class 6. The size of tracts that can be developed for irrigation, however, will be limited due to the relatively high percentage of interspersed non-irrigable land.

8. Rockland-Billings Association

This association is rough and broken. It is characterized by steep canyon walls, buttes, escarpments, outcrops of shale and sandstone, and relatively narrow valley floors. With the exception of alluvial soils in the valley bottoms, the soils generally are shallow. This unit which is located in the southern part of the county, includes about 71,100 acres, or two percent of the land area in the county.

Soil Characteristics. Rockland, a miscellaneous land type, and shallow soils make up the major part of the association. Rockland is usually very steep exposures of sedimentary rocks on escarpments, buttes, and ledges. A thin mantle of soil material of variable texture commonly occurs between the ledges or outcrops of bedrock.

Billings soils are mainly on the nearly level to gently sloping valley bottoms and adjacent valley-filling slopes. They are calcareous throughout, deep, and moderately fine-textured. These soils have a thin surface layer of light gray or light brownish-gray silty clay loam. The underlying material to a depth of five or more feet is dominantly a light brownish-gray silty clay loam or clay loam. There are toxic concentrations of soluble salts in many of the Billings soils in this unit. They are also subject to piping and severe gully erosion.

Other soils of importance in this association include those of the Christianburg, Moenkopie, and Sundown series. The Christianburg soils occur in the valley bottoms in close association with those of the Billings series. They are deep, calcareous, and fine-textured. The deep Sundown soils typically have light-brown loamy sand surface layers and subsoils. This is underlain by loamy sand or sand. The Moenkopie soils have a surface layer of pale brown to yellowish-brown calcareous sandy loam. This is underlain by sandy loam or loamy fine sand that often contains a few angular fragments of sandstone gravels and cobbles. Sandstone bedrock is typically encountered at depths ranging from about 10 to 18 inches.

Present Land Use. The lands in this association are used for the grazing of livestock and wildlife. The vegetative cover ranges from barren to nearly barren on the shale and sandstone outcrops to fairly dense stands on the more favorable soil sites. Galleta, alkali sacaton, Indian ricegrass, and blue grama represent the more common grasses. Shrubs and woody species include pinyon, juniper, greasewood, shadscale, and snakeweed.

Irrigation Potential. This association offers very little potential for the development of irrigated land due to unfavorable soil and topographic conditions.

Although the deep soils in the valley bottoms have properties suitable for irrigation, their shape, size, and location will tend to limit the development for this purpose. In addition, salinity, susceptibility to overflow, and gully erosion are other limiting factors. About 30 percent of this association is in land classes 3 and 4, and the remaining 70 percent is in class 6.

9. Moenkopie Association

The soils of this association occur on gently sloping and undulating upland plains in the western and southern parts of the county. In general, they are developing residually from materials of sandstone origin. The soils in this association, which are characterized by sandy surface layers, are moderately susceptible to wind erosion when the vegetative cover becomes depleted or is removed. This unit includes about 117,500 acres, or three percent of the land area in the county.

Soil Characteristics. A sandy soil (unnamed 62) that is moderately deep over sandstone is the most extensive soil in this association. These soils have a thin surface layer of light brown or brown calcareous fine sandy loam. The subsoil, which is of similar color and texture, contains some segregated lime in the lower part in the form of thin white streaks and small soft masses. Sandstone bedrock is usually encountered at depths ranging from about 20 to 35 inches.

Moenkopie soils that are shallow to sandstone are also relatively extensive in this mapping unit. They have a thin surface layer of light brown calcareous fine sandy loam. This is underlain by fine sandy loam or very fine sandy loam that usually contains a few small angular fragments of sandstone. Sandstone bedrock typically underlies these soils at depths ranging from 10 to 20 inches.

In addition to the two principal soils, miscellaneous land types and soils of minor extent comprise about 20 percent of the association. Rockland, consisting essentially of exposures of sandstone, is the principal land type. A shallow soil over a gravel and a deep sandy soil comprise minor acreages in this association.

Present Land Use. The soils of this association are best used as rangeland. They support a fair cover of grasses and shrubs under good management. Native vegetation includes galleta, blue grama, Indian ricegrass, sand dropseed, poverty three-awn, rabbit brush, and snakeweed.

Irrigation Potential. This association, although containing a relatively high percentage (about 65 percent) of irrigable land, is dominated by soils poorly suited to irrigation. This is reflected in the irrigation land classification, as only 10 percent is in land class 2, while 55 percent is class 4. The remaining 35 percent is in land class 6. The soils in this unit are generally underlain by sandstone bedrock, so drainage problems could develop under irrigation. More detailed soil investigations are recommended prior to considering these soils for irrigation.

10. Persayo-Billings Association

This association occurs mainly west of the Chaco River in the northwestern part of the county. It is characterized by undulating to rolling, and moderately dissected plains with locally prominent uplands comprising hogbacks, mesas, domes, and volcanic outcrops. The soils, which are light colored, calcareous, and highly erodible are forming in material weathered from yellow or gray cretaceous clay shales. Approximately 328,000 acres or 9 percent of the land area of the county is included in this association.

Soil Characteristics. Persayo soils, the most extensive in the association, have a thin surface layer of light gray to pale yellow granular silty clay loam. They have a pale yellow or light yellowish-brown, calcareous silty clay loam subsoil that usually contains moderate amounts of partly weathered shale fragments. A few streaks and small soft masses of lime and crystals of calcium sulfate are also common throughout this horizon. The depth to shale ranges from about 6 to 18 inches.

The Billings soils typically occur in swales and on flood plains of intermittent drainages. They are calcareous throughout, deep, and moderately fine-textured. These soils have a thin surface layer of light gray or light brownish-gray silty clay loam. This is underlain by weakly stratified silty clay loams, silt loams, and clay loams to a depth of five feet or more.

Included in the association are small acreages of Christianburg and Ravola soils. The Christianburg soils are deep and fine-textured; the Ravola soils, deep and medium-textured. Badland, Rockland, and gullied land also comprise minor acreages in this association.

Present Land Use. Although the soils of this association generally support only a sparse cover of vegetation, they are best suited to use as rangeland. Shadscale and galleta grass are the dominant vegetation. Other grasses and shrubs of importance include Indian ricegrass, alkali sacaton, globemallow, snakeweed, and various annuals.

Irrigation Potential. The Billings and associated deep alluvial soils have properties suitable for use as cropland under irrigation. Approximately seven percent of this association is in irrigation land class 2, 26 percent in class 3 and three percent in class 4. Even though over 117,000 acres of land have been classified as suitable for irrigation, the potential for expansion of irrigation in this unit is very limited. These irrigable lands occupy swales and low lying positions in association with the shallow soils of the Persayo series. In addition to the problems inherent in the transportation of irrigation water to small isolated tracts, the soils included in the irrigable land classes are susceptible to accumulation of salts and development of unfavorable drainage conditions.

11. Persayo-Rockland Association

This association comprises an area of approximately 202,000 acres in the southwestern part of San Juan County. A gently sloping to undulating and rolling type of topography prevails throughout the areas included in this unit. A characteristic feature of the landscape, however, is the low tilted ridges and ledges with outcrops of bedrock. Although differences in local relief are not great, the faces or exposures of sandstone and interbedded shale outcrops are nearly vertical or very steep.

Soil Characteristics. Persayo soils, the most extensive, are typically underlain by shale beds at a depth of less than 20 inches. They have a thin surface layer of light gray to pale yellow granular silt loam or silty clay loam. This is underlain by a light yellowish-brown, calcareous silty clay loam subsoil that usually contains moderate amounts of partly weathered shale fragments. A few fine streaks and soft masses of lime and crystals of gypsum are also common in the subsoil immediately above the underlying shale.

A sandy soil (unnamed 62) that is moderately deep over sandstone is also relatively extensive in this association. These soils have a thin surface layer of light brown or brown calcareous fine sandy loam. The subsoil, which is of similar color and texture, typically has a few fine streaks and small soft masses of lime in the lower part. These soils typically are underlain by sandstone bedrock at depths ranging from 20 to 35 inches.

Rockland, a miscellaneous land type, is also an extensive component of this association. It is a complex of very shallow soils, outcrops of sandstone and other types of sedimentary rocks. These outcrops often occur as relatively low, very steep or nearly vertical exposures or ledges.

Also, in this association, are Billings and Woodrow soils, which are moderately fine-textured, and Christianburg soils, which are fine-textured. In addition to these deep soils, shallow soils over gravels and cobbles occur to a limited extent. They are mainly on the crests and side slopes of piedmont fans.

Present Land Use. The soils of this association, which support only a sparse cover of vegetation, are best used as rangeland. Native vegetation includes galleta, Indian ricegrass, alkali sacaton, shadscale, globemallow, snakeweed, and various annuals.

Irrigation Potential. There is very little potential for development of irrigated land in the areas included in this association. Although soils of the Billings, Christianburg, and Woodrow series are irrigable, they are of limited extent in this unit, and often occur in small isolated tracts which would make irrigation extremely difficult.

12. Chipeta-Sheppard-Shiprock Association

This association includes an area of about 149,500 acres in the south-central part of the county. It consists dominantly of erosional slopes intermediate between the uplands on the east and the flood plain of the Chaco River to the west. Locally there are small, nearly level to gently sloping, flood plains contiguous to the intermittent drainages. In addition, gently sloping and undulating valley slopes and intermediate uplands with a mantle of eolian or alluvial sandy materials of varying thickness comprise a significant part of this association. Although geographically associated, the soils in the unit have contrasting characteristics and properties, ranging from deep sandy soils forming in eolian sands to those shallow over shale.

Soil Characteristics. Chipeta soils, the most extensive, are shallow and fine-textured. They are developing on rolling uplands, ridges, and steeply sloping parts of valley-side slopes. They have thin surface layers of pale brown to light yellowish-brown calcareous clay. This layer grades through a light yellowish-brown or gray clay to shale at depths of 10 to 20 inches. Numerous exposures of shale and coal are associated with these soils.

Sheppard soils, which are deep and sandy, are developing in sandy eolian materials. They have surface layers of loose, weakly calcareous pale brown or light reddish brown, loamy sand which are underlain by loamy sand or sand to a depth of five feet or more.

Shiprock soils, in this association, usually occur in the level or nearly level and more stable areas. They have thin light brown or light reddish-brown noncalcareous surface layers and reddish-brown sandy clay loam subsoils. The substratum is a reddish-brown to reddish-yellow calcareous sandy loam or loamy fine sand. A few fine streaks and small soft masses of lime are usually present in the upper part of the substratum.

Barren or nearly barren exposures of sedimentary rocks and alkali-affected soils comprise from 5 to 10 percent of this association.

Present Land Use. The soils of this association are used as rangeland. Galleta, alkali sacaton, and shadscale represent the dominant native vegetation on the Chipeta soils. However, associated with the Chipeta soils are numerous barren areas of shale and sandstone exposures, slickspots, and thin eroded soils. The Sheppard and Shiprock soils in this association support a fair cover of native grasses and shrubs unless severely eroded. The more common grasses are galleta, sand dropseed, sideoats grama, Indian ricegrass, and blue grama.

Irrigation Potential. The potential for the development of irrigated land in this association is very limited. The Sheppard and Shiprock soils, which are suitable for irrigation, commonly occur in relatively small tracts surrounded by large areas of non-irrigable land. In addition, the Sheppard soils, because of their low water-holding capacity and high susceptibility to wind erosion, have severe limitations for use as cropland under irrigation.

13. Rockland-Shallow Soil Association

This association comprises an area of about 116,000 acres in the northwestern part of San Juan County. It is a very dissected area with extremes in relief. It consists generally of a series of angular tilted ledges of sandstone rock, and plateaus bounded by deeply incised valleys and drainages which expose sandstone and other interbedded sedimentary rocks. The area is dominated by sandstone rockland and shallow soils developing on sandstone and shale. Deep alluvial soils occur in the narrow valleys and drainage ways.

Soil Characteristics. Rockland, a miscellaneous land type, is extensive in this association. It consists generally of a complex of shallow soils, outcrops of sandstone, and other types of sedimentary rocks. The sandstone rock outcrops may occur as angular tilted ledges or on very steep canyon walls and escarpments. A thin mantle of soil material often occurs between the outcrops of bedrock.

A shallow soil (unnamed 101), developing over sandstone on the nearly level to gently sloping areas, is also relatively extensive in this association. These soils have a thin surface layer of light reddish-brown calcareous loam. This is underlain by reddish-brown calcareous loam or clay loam. Sandstone bedrock typically underlies these soils at depths ranging from 10 to 20 inches.

Also of importance in this unit are the deep alluvial soils in the narrow valley bottoms and on the adjacent valley slopes. These soils, which are dominantly medium-textured, may range in texture from moderately course to moderately fine.

A few exposures or outcrops of shale and shallow soils developing over shale also are included in this unit.

Present Land Use. The soils of this association are used as rangeland and for recreational areas. The more common native vegetation includes juniper, pinyon, galleta, blue grama, Indian ricegrass, snakeweed, yucca, and shadscale.

Irrigation Potential. There is very little potential for development of irrigated lands in the areas comprising this association due to the prevalence of rough, broken, and steep topography, rock outcrops, and shallow soils. The only irrigable soils are the deep soils in the valley bottoms, which have been placed in class 4. The location, shape, and small extent of these soils will tend to limit their use as irrigated cropland.

14. Travessilla-Rockland Association

This association comprises relatively extensive areas in the northeastern part of San Juan County. It includes an area of about 336,000 acres, or 10 percent of the land area in the county. This unit is characterized by rough broken topography. The relatively narrow valley floors and upland summits are separated by steep canyon walls and escarpments. The fans and valley floors below the canyon walls or escarpments are gently to strongly sloping. The mesa tops or upland areas, which are usually comparatively small, are gently sloping to rolling. Thin deposits of silty eolian materials or gravelly alluvium cover a considerable part of the upland area. Outcrops of sandstone bedrock are also a common feature of these upland areas.

Soil Characteristics. Travessilla soils, the most extensive, are shallow, light-colored, gently to strongly sloping soils developing on sandstone mesas and breaks. They have a thin surface layer of light brownish-gray to pale brown sandy loam. The subsoil consists of pale brown calcareous fine sandy loam. This is underlain by sandstone bedrock at depths ranging from 8 to 12 inches. Small angular fragments of sandstone are common in the subsoil above the bedrock.

Rockland, a miscellaneous land type, is also

an extensive component of this association. It is a complex of shallow soils, outcrops of sandstone, and other types of sedimentary rocks. The sandstone outcrops commonly occur as vertical exposures or ledges. A thin mantle of rocky or stony soil material generally occurs between the ledges or outcrops of bedrock.

Exposures of shale may also occur on the lower parts of the breaks and escarpments. Associated with these outcrops of shale are shallow soils (unnamed 111) forming in materials of shale origin. They occupy the gently sloping to rolling areas at the base of escarpments and cliffs. They have thin surface layers of grayish-brown calcareous clay loam or silty clay loam. This grades through soil material of similar color and texture to the underlying shale which usually occurs at depths of 10 to 20 inches.

Other soils of lesser extent in this association include the deep alluvial soils in the valley bottoms, shallow to moderately deep gravelly soils developing in alluvium on the upland ridges and soils of the Del Rio series. The Del Rio soils, which are deep, have thin surface layers of reddish brown loam and blocky silty clay loam subsoils. The deep alluvial soils in the narrow bottoms are usually grayish brown or brown and range in texture from medium to fine. The gravelly soils occur on the upland ridges and slopes in the northern parts of this unit near the Colorado-New Mexico state line. They have dark-colored gravelly or cobbly loam surface soils and blocky clay subsoils.

Present Land Use. The soils of this association are used principally for grazing by livestock and wildlife. Although the density of vegetation is somewhat restricted due to rock outcrops, thin soils, and steep slopes, this unit does support a wide variety of grasses and shrubs. Blue grama, galleta, sideoats grama, Indian ricegrass, little bluestem, poverty three-awn, and sand dropseed are the principal grasses. The more common shrubs and woody species include pinyon, juniper, big sage, bitterbrush, serviceberry, snakeweed, rabbit brush, and cactus. The use of land in this unit for recreational purposes is also of considerable importance. In addition to fishing available in Navajo Reservoir, this association provides a good habitat for many species of wildlife.

Irrigation Potential. Due to the preponderance of shallow soils, and steep, rough broken landscapes, there is little, if any, opportunity for the development of irrigated land in this association. The Del Rio soils, which account for six percent of the association, have been placed in classes 2 and 3, primarily due to slope and unevenness of the land surface. They occur as small isolated tracts on mesa tops and ridges. The deep alluvial soils also occur as small areas. However, in contrast to the Del Rio soils they occupy flood plains and canyon bottoms where they are subject to overflow.

15. Del Rio - Caja Association

This association, which occurs on the gently sloping and undulating summits or tops of plateaus and mesas in the northwestern part of the county, is relatively inextensive. It comprises an area of about 40,500 acres or slightly more than one percent of the county. It consists dominantly of deep upland soils developing in silty eolian and alluvial sediments.

Soil Characteristics. Del Rio soils, the most extensive, are mainly on the crests or higher parts of the areas in this unit. They have a thin surface layer of brown noncalcareous loam. The subsoil is a moderately thick brown to reddish-brown clay loam that is leached free of lime in the upper part. Below the subsoil is a light reddish-brown calcareous loam or light clay loam with some visible lime in the form of fine soft masses and threads.

Caja soils are mainly on the level or nearly level areas and lower parts of side slope fans. They have a moderately thick surface layer of brown noncalcareous loam over a thick subsoil of grayish-brown heavy silty clay loam which usually contains a few fine soft masses and threads of lime.

Also in this association are small inclusions of deep sandy soils and deep loamy soils, as well as soils of the Travessilla series. The Travessilla soils, which are shallow over sandstone, usually occur on the outer fringes or more sloping parts of this mapping unit.

Present Land Use. The soils of this association are used for the grazing of livestock and wildlife. Moderate to good yields of forage are obtained under good management. Dry-land farming has been practiced unsuccessfully to a very limited extent on the soils of this association. Precipitation, however, is too limited to successfully farm these soils, hence none are under cultivation at the present time. Native vegetation includes big sagebrush, blue grama, western wheatgrass, and galleta. Thin stands of pinyon and juniper are also common, particularly near the

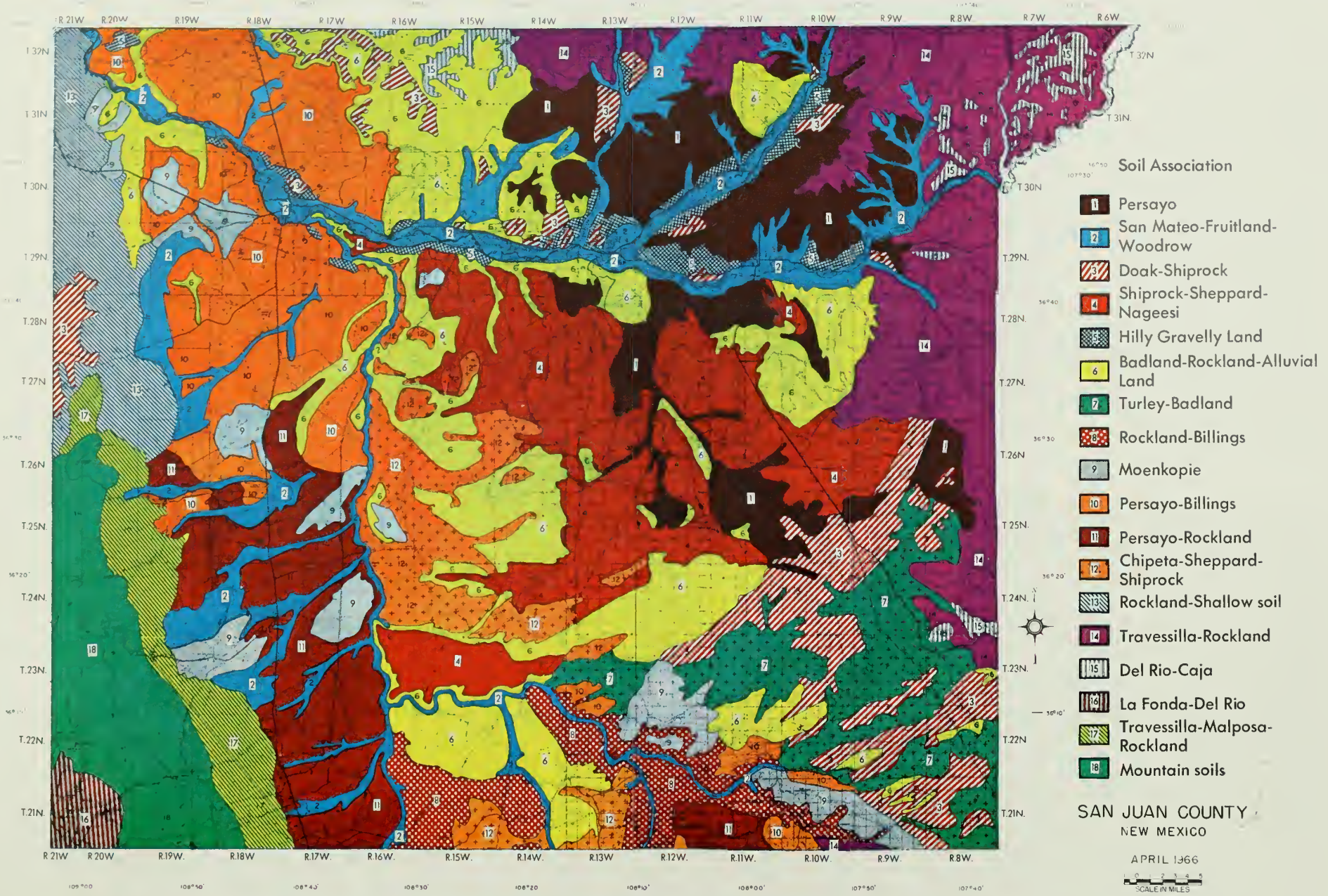

Figure 1. General Soil Map of San Juan County, New Mexico

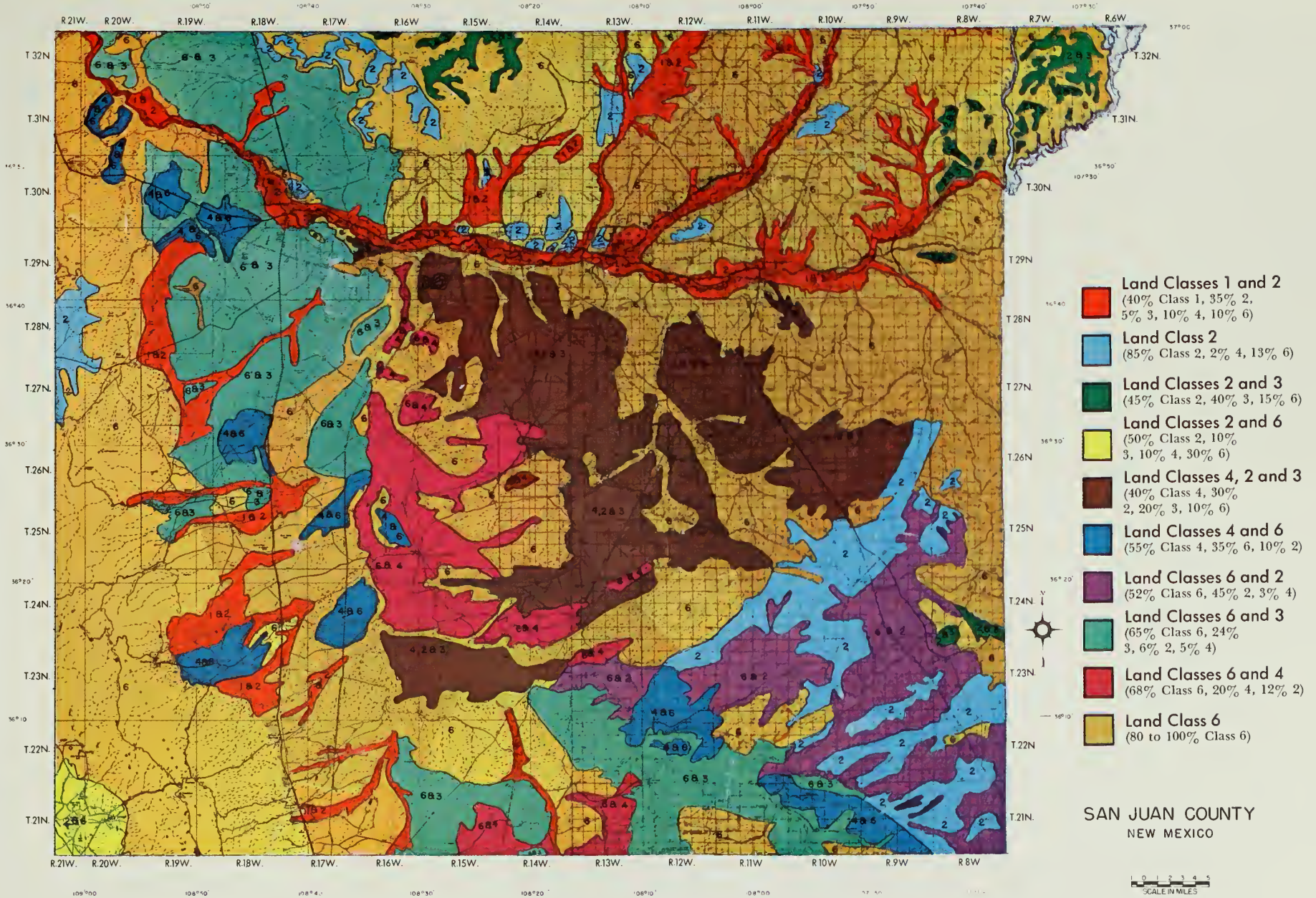

Figure 2. Classification of Land for Irrigation in San Juan County, New Mexico

outer edges of the association near the adjacent breaks or rough broken lands.

Irrigation Potential. The major soils in this association have characteristics and properties favorable for their use as irrigated cropland. The small size and location on mesa tops and ridges of many of the areas in this association will, however, undoubtedly present problems in transporting irrigation water to these lands. Approximately 45 percent of the land in this association is in land class 2, 40 percent in class 3, and 15 percent in class 6.

16. La Fonda - Del Rio Association

This association includes the area locally known as "Black Salt Valley" in the extreme southwestern part of San Juan County. It is the least extensive of all the soil associations, as it includes only an area of about 24,200 acres, or slightly less than one percent of the county. It is an area characterized by relatively broad, gently sloping piedmont slopes or upland valleys and moderately sloping to rolling uplands. The soils which are dominantly deep are developing in medium and moderately fine-textured sediments derived from Jurassic and Triassic Redbeds.

Soil Characteristics. La Fonda soils, the most extensive in the association, occur on broad gently sloping alluvial fans and piedmont slopes. These soils have thin surface layers of reddish brown weakly calcareous loam. Their subsoil is a light reddish-brown, calcareous heavy loam. A substratum of light reddish-brown loam with a few small soft masses and seams of segregated lime is encountered at an average depth of 25 inches.

The Del Rio soils occupy the moderately sloping and rolling uplands in this association. They have a thin surface layer of brown noncalcareous loam. The subsoil is a moderately thick light reddish-brown to reddish brown clay loam that is noncalcareous in the upper part. This is underlain by a light reddish-brown or clay loam that contains a few fine soft masses and seams of lime.

Rockland, a miscellaneous land type, is also of minor importance in this association. It consists of a complex of sandstone and shale outcrops and associated shallow soils. A small acreage of deep alluvial soils on the flood plains of the larger intermittent drainages are also included in this unit. They are typically medium to moderately-fine textured.

Present Land Use. The dominant vegetation on the soils of this association consists of blue grama, galleta, Indian ricegrass, and big sagebrush. Thin and scattered stands of juniper trees are common on the shallow soils and at the higher elevations where this unit joins the Chuska Mountain range. It is used for grazing of livestock.

Irrigation Potential. Although this is a relatively small unit, about 70 percent of the land in this association is suitable for irrigation.[7] This area therefore offers some potential for development of irrigated land; particularly if the irrigable land in this association is considered with that in adjacent counties.

17. Travessilla-Malposa-Rockland Association

This association is mainly in the foothills on the eastern slopes of the Chuska Mountains. It is characterized by steep and rough broken topography including rock outcrops, rock slides, and escarpments. The exposed rock areas on the steep slopes and escarpments are dominated by sandstone. Interspersed with the steep or very steeply sloping rock outcrops and escarpments are relatively narrow valley floors and moderately steep to rolling uplands. It comprises an area of about 101,900 acres or slightly less than three percent of the county.

Soil Characteristics. Travessilla soils, which are underlain by sandstone at depths of 8 to 20 inches, occur on the moderately steep to rolling upland areas. They have a thin surface layer of light brown sandy loam. This grades through soil material of similar color and texture until sandstone is encountered at depths ranging from 8 to 20 inches. It is common for the subsoil to contain small angular fragments of sandstone just above the bedrock.

Malposa soils are developing in a mantle of stony alluvial material overlying shale and sandstone on moderately steep to hilly uplands. In general they have a thin surface layer of brown, noncalcareous stony loam or stony fine sandy loam. Their subsoil is a light brown to brown clay or light clay that is calcareous in the lower part. A substratum of pinkish-white loam with a high lime content is at depths ranging from 18 to 30 inches.

Rockland, a miscellaneous land type, is also

[7] This suitability for irrigation is reflected in the land classification, as about 50 percent of the land in this general soil area is in class 2, 10 percent in class 3, 10 percent in class 4, and 30 percent in class 6.

an extensive component of this association. It is a complex of shallow soils, outcrops of sandstone and other sedimentary rocks. The sandstone outcrops commonly occur as vertical or nearly vertical exposures or ledges. A thin mantle of cobbly or stony soil material usually occurs between the outcrop of bedrock.

Other soils of lesser extent in this association include deep alluvial soils and shallow to moderately deep gravelly soils. The deep alluvial soils occupy the narrow valley bottoms. Although quite variable, they usually are medium to moderately-fine textured. The gravelly soils occur on upland ridges and slopes. Gravelly loams and gravelly clay loams are the more common textures.

Present Land Use. The soils of this association are best used as rangeland or recreational sites. They support a wide variety of native vegetation, including pinyon, juniper, big sage, bitterbrush, snakeweed, chamiza, blue grama, sideoats grama, galleta, and Indian ricegrass.

Irrigation Potential. The potential for development of irrigated land in this association is very limited due to rough broken topography, steep slopes, and shallow soils. The limited acreage of soils suitable for irrigation commonly occurs in small tracts intermingled with large areas of non-irrigable soils.

18. Mountain Soils

This association includes the Chuska Mountains area in the southwestern part of the county. The altitude ranges from about 7,000 to slightly more than 9,300 feet, but is most commonly between 7,500 and 9,000 feet. It is characterized by a relatively broad gently sloping to rolling plateau or mountain top and very steeply sloping side slopes and escarpments. The rough, very steep, and mountainous topography typical of the side slopes is more extensive than that occurring on the ridge crests. The soils in this unit are developing dominantly in parent materials of sandstone origin. Other sedimentary rocks and eolian sediments have contributed minor amounts to the parent materials.

The association comprises an area of about 171,000 acres, or five percent of the county.

Soil Characteristics. A deep, dark-colored soil (unnamed 201) developing on the steep mountain slopes represents one of the more extensive soils in this association. It has a thick surface layer of grayish brown to black noncalcareous loam. It is typically underlain to a depth of five feet or more, by yellowish-brown loam and sandy loam. A few outcrops of sandstone may occur locally.

A shallow soil (unnamed 203) forming over sandstone is also relatively extensive in this association. It commonly occurs on the outer edges of the ridge crests and mountain plateaus or tops. These soils usually have moderately thick surface layers of very dark gray noncalcareous loam and a subsoil of brown fine sandy loam or loam. They are generally underlain by sandstone bedrock at depths of less than 24 inches. In addition to sandstone outcrops that occasionally occur locally, a few angular sandstone gravels and cobbles are common in these soils.

In addition to the shallow soils on the gently sloping to rolling mountain tops or plateaus, deep dark-colored soils (unnamed 202) are moderately extensive in this part of the mapping unit. They occupy the nearly level to gently sloping open park areas, or mountain valleys. These soils have thick surface layers of very dark brown noncalcareous loam. Their subsoil is a brown noncalcareous sandy clay loam or loam. Sandstone bedrock usually occurs at depths greater than 60 inches.

Rockland, a miscellaneous land type, is common in the rough and very steep mountainsides. It is a complex of shallow soils, outcrops of sandstone and other sedimentary rocks. A thin mantle of soil often occurs on the steep breaks and escarpments between the outcrops of bedrock.

Included in this unit is also a small acreage of deep alluvial soils. They usually occur on narrow flood plains contiguous to intermittent drainages. Although normally quite variable, in general, they are deep, moderately permeable and range in texture from medium to moderately fine.

Present Land Use. The soils of this association are best used for forestry, range, and recreation. The major soils in the unit are relatively productive and support good stands of native vegetation. The overstory vegetation consists dominantly of ponderosa pine, Gambel oak, and some pinyon and juniper. The more common grasses include Arizona fescue, mountain brome, bluegrass, needlegrass and blue grama. They also support a number of desirable browse plants, such as, mountain mahogany, cliffrose, vetch, and peavine. This association, with its capability to produce a wide variety of vegetation, provides good habitats for many species of wildlife. In addition to offering many opportunities for outdoor recreation, essentially all of the

commercial timber harvested in San Juan County is produced on the soils of this association.

Irrigation Potential. The potential for the development of irrigated land in this association is very limited. The soils with characteristics suitable for irrigation occur on the broad plateaus or mountain tops. The growing season and choice of crop will be very limited at these high elevations, which range from 8000 to 9000 feet.

Interpretation of Soils for Irrigation

The major soils and miscellaneous land types within each soil association were placed into one of four irrigable and one non-irrigable classes of land. The criteria used to classify the soils were those proposed at a 1967 conference organized by federal Water Resources Council[8], as modified on January 12, 1968. These criteria were agreed upon by authorities from several organizations concerned with land classification, and thus appear to have particularly high reliability.

The classification system establishes four classes of irrigable land and one class of non-irrigable land. The limitations for use under irrigation increases from class 1 through 4. For example, class 1 land has few or no limitations for irrigation. It is productive and, with good management will produce high yields of most climatically adapted crops under irrigation. Class 2 land has slight to moderate limitations for sustained use under irrigation. These are moderately productive lands, or are lands that require better than average management for high yields of climatically adapted crops. Class 3 land has moderate to severe limitations for sustained use under irrigation. These lands have restricted productivity for most climatically adapted crops, or are lands that require a very high level of management to obtain moderate to high yields. Class 4 land has very severe limitations for sustained use under irrigation. The lands included in this class are generally adapted only to a few of the climatically adapted crops. In some cases specialized high income crops may be grown or produced under a very high level of management. Class 6 land is not suitable for irrigation.

The irrigation land classes are based primarily on soil properties and qualities that affect their suitability for continued use under irrigation. The availability, or the costs of pumping and conveyance of irrigation water does not enter into the classification. The shape, size, and location of lands with respect to other lands to be developed are also factors not considered in the classification. The detailed criteria used to determine irrigation land classes are listed in table 4.

The factors of major importance in determining the placement of soils in the various irrigation land classes in San Juan County are soil texture, moisture retention, effective soil depth, permeability, salinity, erosion, slope, surface smoothness, internal soil drainage, and surface drainage. The Persayo soils, for example, are classed as non-irrigable because of their shallow depth, salinity, low moisture-retention, and internal soil drainage limitations. In many other areas, steep slopes and rough broken topography, together with shallow soils were the dominant factors in placing soils in a non-irrigable class.

Irrigation Land Classes

The acreage of irrigable land in each of the soil associations is shown in table 5. These estimates of irrigable land were determined on the basis of the kinds of soils occurring within each of the soil associations.

The five soil associations or general soil areas that contain the highest percentage of irrigable land are:

2. San Mateo-Fruitland-Woodrow Association
3. Doak-Shiprock Association
4. Shiprock-Sheppard-Nageesi Association
15. Del Rio-Caja Association
16. La Fonda-Del Rio Association

The Shiprock-Sheppard-Nageesi (Number 4) association has the largest continuous tracts of irrigable land, and contains about 316,800 acres of land suitable for cropland use under irrigation. However, approximately 40 percent of this acreage is in class 4 because of the sandy nature of the soils, their low moisture-retention capacity, and undulating or rolling topography.

In addition to the class 4 land this association contains approximately 30 percent class 2 land and 20 percent class 3 land. The lands in these classes have sufficient productive capacity to support

[8]Proceedings Water Resources Council Irrigation Land Classification Seminar, Salt Lake City, Utah, July 1967.

Table 4. Land classification specifications for Pac. Southwest Basin irrigation land classes[1]

Land Characteristics	Class 1	Class 2	Class 3	Class 4	Non-irrigable Class 6
Soils					
Texture (Surface 12")[2]	LVFS-CL	LS-C Peat, Muck	MS-C	MS-C	All other lands not meeting criteria for arability
Moisture Retention (AWHC-48")[3]	> 6.0"	4.5" 6.0"	3.0" 4.5"	2.5" 3.0"	
Effective Depth (inches)	> 40[4]	30- 40	20 - 30	10 - 20	
Salinity ($EC_e \times 10^3$ - equil.)	< 4	4 - 8	8 - 12	12 - 16	
Sodic Conditions[5]					
Percent area affected	< 5	5 -15	15 - 25	25 - 35	
Severity of problem[6]	Slight	Moderate	Moderate	Moderate	
Permeability (in place - in/hr)	0.2-5.0	0.05-5.0	0.05-10.0	Any	
Permissible coarse fragments (% by vol.)					
Gravel	15	35	55	70	
Cobbles	5	10	15[7]	35[7]	
Rock Outcrops (distance apart in feet)	200	100	50	30	
Soil Erosion (for all classes)	Severely eroded soils will be downgraded one class. Less severely eroded soils may be downgraded one class, depending on other conditions.				
Topography (or land development items)[8]					
Stone for Removal (cubic yards per acre)	10	25	50	70	
Slope (percent)					
Moderately to severely erodible	< 2	2 - 5	5 - 10	10 - 20	
Slightly erodible	< 4	4 - 10	10 - 20	20 - 25	
Surface Leveling or Tree Removal (amount of cover)	Light	Medium	Medium heavy	Medium heavy	
Irrigation Method	Lands unsuited to gravity irrigation where land grading would permanently reduce soil fertility below arable limits or exceed permissible costs, or field pattern too complex, may be considered for sprinkler. Land must meet other requirements for arability. Designate by "S" - example, 3-S.				
Drainage					
Soil Wetness (depth to water table during growing season with or without drainage)					
Loam or finer	> 60"	40" - 60"	20" - 40"	10" - 20"	
Sandy	> 50"	30" - 50"	20" - 30"	10" - 20"	
Surface Drainage	Good	Good	Restricted	Restricted	
Depth to Drainage Barrier (in feet)	> 7	6 - 7	5 - 6	1.5 - 5	
Air Drainage[9]	No Problem	Minor	Restricted	Restricted	

[1]Specifications are representative of conditions after land is developed for irrigation. Each individual factor represents a minimum requirement, and unless all other factors are near optimum two or more interacting deficiencies may result in land being placed in lower class or designated class 5 -- non-irrigable.

[2]Finer textures may be required than those indicated for each class in areas subject to critical hot spells or wind; coarser textures may sometimes be permissible.

[3]In areas of very warm growing season 3" may be required for class 4 and in cold areas as little as 5" may be permitted for class 1.

[4]Depth of 60" or more is required for class 1 where deep-rooted crops are important.

[5]More extensive and severe sodic problems may be tolerated in areas of wide crop adaptability.

[6]Severity of problem: Slight - ESP less than 15% or less than 25% if dominated by nonswelling clays; moderate - ESP less than 20% or less than 30% if clay minerals favorable; severe - ESP less than 30%; with certain soil minerals may range above 50% as measured by usual techniques.

[7]May range above 50% in subsoil for certain crops if surface soil is favorable.

[8]Special crop and management practices may justify exceeding the limits for stone removal or slope in class 4; irregularity of slope may necessitate downgrading of class unless deficiency is compensated for by possibility of sprinkler irrigation.

[9]Air drainage is a consideration mainly in areas adapted to fruit or to early or late vegetables.

Abbreviations:

LVFS - loamy very fine sand
LS - loamy sand
MS - medium sand
CL - clay loam
C - clay
AWHC - available water holding capacity
ESP - exchangeable sodium percentage

Table 5. Irrigation land class, by soils, San Juan County, New Mexico

Soil Map Symbol and Soil Association	Soil	Approximate Percentage	Approximate Acres	Irrigation Land Class	Principal Limiting Factors
1 Persayo	Shiprock fine sandy loam	5	14,524	2	AWHC* and slope
(290,460 acres)	Sundown loamy sand	10	29,045	4	AWHC*
	Rockland	5	14,524	6	Topography and soil
	Persayo silty clay loam	40	116,184	6	Soil depth
	Moenkopie sandy loam	30	87,138	6	Soil depth
	Badland	10	29,045	6	Topography and soil
2 San Mateo-Fruitland-Woodrow	San Mateo loam	14	43,472	1	None
(310,550 acres)	Woodrow clay loam	11	34,162	1	None
	Turley clay loam	6	18,633	1	None
	Other soils	4	12,422	1	None
	Fruitland sandy loam	5	15,528	2	AWHC*
	Turley clay loam	6	18,633	2	Slope
	Unnamed 22 loam	15	46,582	2	Slope
	Other soils	9	27,950	2	Slope; salinity; erosion
	San Mateo loam, wet and saline	1	3,105	3	Salinity and wetness
	Woodrow clay loam, wet and saline	4	12,420	3	Salinity and wetness
	Fruitland sandy loam	3	9,316	3	Slope and AWHC*
	Other soils	2	6,211	3	Soil depth and AWHC*
	Christianburg clay	5	15,528	4	Salinity; permeability; texture
	Sundown loamy sand	5	15,528	4	Soil texture and AWHC*
	Miscellaneous land types	10	31,055	6	Topography and soil
3 Doak-Shiprock	Doak loam	35	66,325	2	Slope
(189,500 acres)	Shiprock fine sandy loam	25	47,375	2	AWHC* and slope
	Unnamed 46	25	47,375	2	Slope
	Other soils	2	3,790	4	AWHC* and soil depth
	Persayo silty clay loam	5	9,475	6	Soil depth
	Other soils	5	9,475	6	Soil depth
	Miscellaneous land types	3	5,685	6	Topography and soil
4 Shiprock-Sheppard-Negeesi	Shiprock fine sandy loam	30	105,612	2	AWHC* and slope
(35,204 acres)	Negeesi sandy loam	20	70,408	3	AWHC* and shallow to lime zone
	Sheppard loamy sand	25	88,010	4	AWHC*
	Unnamed B	15	52,806	4	AWHC* and permeability
	Persayo silty clay loam	5	17,602	6	Soil depth
	Other soils	5	17,602	6	Soil depth
5 Hilly-Gravelly Land	Doak loam	4	3,312	2	Slope
(82,800 acres)	Unnamed 46	4	3,312	2	Slope
	Hilly-Gravelly land	75	62,100	6	Topography and soil
	Other miscellaneous land types	12	9,936	6	Topography and soil
	Other soils	5	4,140	6	Soil depth and slope
6 Badland-Rockland Alluvial Land	Alluvial land	1	5,120	2	Overflow
(511,950 acres)	Rockland	20	102,390	6	
	Badland	50	255,975	6	Topography and soil
	Alluvial land	14	71,672	6	Salinity and overflow
	Persayo silty clay loam	5	25,598	6	Soil depth
	Other soils and miscellaneous land types	10	51,195	6	Soil depth and topography

7 Turley-Badland (132,370 acres)	Turley clay loam	35	46,330	2	Slope
	Unnamed 32	10	13,237	2	Slope
	Other soils	3	3,971	4	AWHC*
	Moenkopie sandy loam	20	26,474	6	Soil depth
	Badland	20	26,474	6	Topography and soil
	Other soils	7	9,266	6	Soil depth
	Other miscellaneous land types	5	6,618	6	Topography and soils
8 Rockland-Billings (71,160 acres)	Billings silty clay loam	15	10,674	3	Permeability and salinity
	Other soils	2	1,423	3	Salinity and permeability
	Christianburg clay	10	7,116	4	Salinity and permeability
	Other soils	3	2,135	4	Soil texture and AWHC*
	Rockland	60	42,696	6	Topography and soil
	Moenkopie sandy loam	10	7,116	6	Soil depth
9 Moenkopie (117,470 acres)	Unnamed 63	10	11,747	2	Slope and AWHC*
	Other soils	5	5,873	4	Soil depth and AWHC*
	Unnamed 62	50	58,735	4	Soil depth and AWHC*
	Moenkopie SL	30	35,241	6	Soil depth
	Miscellaneous land types	5	5,874	6	Topography and soils
10 Persayo-Billings (328,010 acres)	Other soils	7	22,961	2	Salinity and overflow
	Billings silty clay loam	26	85,283	3	Permeability and salinity
	Christianburg clay	3	9,840	4	Salinity and permeability
	Persayo silty clay loam	60	196,806	6	Soil depth
	Miscellaneous land types	4	13,120	6	Topography and soil
11 Persayo-Rockland (202,150 acres)	Other soils	4	8,086	2	Overflow and slope
	Other soils	4	8,086	3	Salinity and overflow
	Unnamed 62	10	20,215	4	Soil depth
	Other soils	2	4,043	4	Soil depth and salinity
	Persayo silty clay loam	40	80,860	6	Soil depth
	Unnamed 62	10	20,215	6	Soil depth and erosion
	Rockland	20	40,430	6	Topography and soil
	Other miscellaneous	10	20,215	6	Topography and soil
12 Chipeta-Sheppard-Shiprock (149,520 acres)	Shiprock fine sandy loam	10	14,952	2	AWHC* and slope
	Other soils	2	2,990	2	Overflow and salinity
	Sheppard loamy sand	17	25,418	4	AWHC*
	Other soils	3	4,486	4	AWHC*
	Chipeta clay	58	86,722	6	Soil depth
	Miscellaneous land type	10	14,952	6	Topography and soil
13 Rockland-Shallow Soil (116,030 acres)	Other soils	5	5,801	4	Salinity; slope; erosion
	Rockland	45	52,214	6	Topography and soil
	Unnamed 101	35	40,610	6	Soil depth
	Other soils	5	5,801	6	Soil depth and slope
	Other miscellaneous land types	10	11,604	6	Topography and soil
14 Travessilla-Rockland (336,090 acres)	Del Rio loam	3	16,804	2	Slope
	Del Rio loam	3	10,083	3	Slope
	Other soils	2	6,722	3	Overflow and erosion
	Other soils	5	16,804	4	Slope; erosion; soil depth
	Travessilla sandy loam	40	134,436	6	Soil depth
	Rockland	25	84,023	6	Topography and soil
	Other miscellaneous land types	10	33,609	6	Topography and soil
	Unnamed 111	10	33,609	6	Soil depth and slope

Table 5. Continued

Soil Map Symbol and Soil Association	Soil	Approximate Percentage	Approximate Acres	Irrigation Land Class	Principal Limiting Factors
15 Del Rio-Caja	Del Rio loam	15	6,083	2	Slope
(40,550 acres)	Caja loam	30	12,165	2	Permeability and slope
	Del Rio loam	30	12,165	3	Slope
	Other soils	10	4,055	3	Slope and AWHC*
	Travessilla sandy loam	10	4,055	6	Soil depth
	Miscellaneous land types	5	2,027	6	Topography and soil
16 La Fonda-Del Rio	La Fonda loam	40	9,688	2	Slope
(24,220 acres)	Other soils	10	2,422	2	Overflow and slope
	La Fonda loam	10	2,422	3	Slope
	Del Rio loam	10	2,422	4	Slope and rock barrier
	Del Rio loam	20	4,844	6	Slope and rock barrier
	Rockland	10	2,422	6	Topography and soil
17 Travessilla-Malposa-Rockland	Other soils	5	5,097	3	Overflow; erosion; slope
(101,950 acres)	Other soils	5	5,097	4	Slope and soil depth
	Travessilla sandy loam	30	30,585	6	Soil depth
	Malposa loam	30	30,585	6	Slope and rock barrier
	Rockland	25	24,488	6	Topography and soil
	Other soils	5	5,098	6	Slope and soil depth
18 Mountain Soils	Unnamed 202	10	17,179	3	Slope and drainage
(171,790 acres)	Other soils	5	8,589	3	Soil depth and slope
	Unnamed 201	35	62,127	6	Slope
	Unnamed 203	20	34,358	6	Soil depth and slope
	Rockland	20	34,358	6	Topography and soil
	Other soils	10	17,179	6	Soil depth

*AWHC is abbreviation for available water-holding capacity.

sustained irrigation, and they are of sufficie quality to warrant consideration for irrigatic development.

Approximately 90 percent (279,500 acres) c the San Mateo-Fruitland-Woodrow (Number 2 association consists of irrigable land. In general, the major soils in this association are well suited for use as cropland under irrigation. This is reflected in the irrigation land classification as about 40 percent of the land in this association is in class 1 and 30 percent in class 2. Although there is considerable potential in this association for the development of additional irrigated land, it is not as great as the acreage tends to indicate. The majority of the presently irrigated (49,000 acres) land occurs in this association. In addition, a significant part of this association is in urban areas, industrial sites, highways, roads, and other built-up areas. The lands in these uses were not deducted from the acreage that is indicated as suitable for irrigation. Another item that will tend to limit the development of irrigated land in this association is the location and wide distribution of the land suitable for irrigation.

About 85 percent of the land in the Doak-Shiprock (Number 3) association is suitable for irrigation. This association also includes numerous small, isolated tracts of land which will present water transportation problems. A few relatively large tracts of irrigable land in this association occur in the southeastern part of the county. The major soils in this unit, however, are in land class 2, hence they are well suited for use as cropland under irrigation. With good irrigation and farming practices, these soils have sufficient productive capacity to support irrigation. As indicated previously, the small size and location of many of the tracts of land suitable for irrigation will undoubtedly tend to limit their use for this purpose.

The Del Rio-Caja (Number 15) association, which is located on high mesas and plateaus in the northeastern part of the county, contains about 34,000 acres of irrigable land. This represents about 85 percent of the association of which approximately 45 percent is in land class 2 and 40 percent in class 3. The location and relatively small size of many of these tracts of irrigable land are factors that will need to be considered in determining the feasibility of developing these lands.

The La Fonda-Del Rio (Number 16) association in the southwestern part of the count was estimated to contain about 16,900 acres c irrigable land. Approximately 50 percent of th acreage is in land class 2, 10 percent in class 3 ar 10 percent in class 4, for a total of about 70 percent of the land in this association. Although the amount of land in this unit suitable for irrigation is small it may warrant consideration if considered with that in adjacent counties.

A summary of the estimated acreage and percentage of land in the various irrigation land classes for these five soil associations with the highest percentages of irrigable land is shown in table 6.

These five soil associations with the highest percentage of irrigable land contain slightly more than 60 percent of the land classified as suitable for irrigation in San Juan County. In addition, they include a relatively high percentage of the land with the best potential for irrigation, as essentially all the class 1 land and slightly more than 70 percent of the class 2 land is within these associations. Although a part of the potentially irrigable land occurs in small tracts and widely distributed, there is considerable potential for expansion of irrigated land in the areas occupied by the five soil associations listed, as far as the availability of suitable soils is concerned. The largest tracts of irrigable land occur in soil associations 3 and 4. A few relatively large bodies of irrigable land also occur in the northern and western parts of soil association 2.

In the remainder of the general soil areas, the percentage of irrigable land ranges from little or none in association 6 to 65 percent in association 9 (see table 5). Although the total acreage (about 525,000 acres) of irrigable land in these associations is relatively large, the opportunity for any significant expansion of irrigated land is very limited or nonexistent. There are a number of factors that undoubtedly will tend to preclude the development of these lands for irrigation. A major item is the wide distribution and common occurrence of the soils classified as suitable for irrigation in small tracts intermingled with large areas of nonirrigable lands. Another item of importance is the limited capabilities of many of the soils involved. For example, soil association 9, which contains a relatively high percentage of irrigable land, is dominated by soils poorly suited to irrigation. Approximately 85 percent of the irrigable land in this association is in land class 4.

The problems and hazards inherent in the irrigation of soils developing on shale or in materials of shale origin will also tend to limit irrigation development. Soil association 10, which is representative of this condition, contains over 117,000 acres of land classified as suitable for irrigation. These lands occupy swales and low lying positions in association with the shallow soils of

the Persayo series. The irrigation, or transportation of irrigation water in unlined ditches on the Persayo and associated soils underlain by shale will tend to create unfavorable drainage conditions and harmful salt accumulations in the soils now classified as irrigable. Therefore, in addition to the problems inherent in the transportation of irrigation water to small isolated tracts, these soils are susceptible to the accumulation of salts and development of unfavorable drainage conditions.

There will also be a need to protect those lands occurring on the flood plains of intermittent drainages from damaging overflows and gully erosion if developed for irrigation. In summation, therefore, it appears very unlikely that there will be any significant increase of irrigated land in those parts of San Juan County not included in the five soil associations referred to in table 6.

The approximate distribution of the irrigation land classes in San Juan County is indicated on figure 2. The estimated acreage and percentage of land in the various irrigation land classes for each soil association as shown in table 5 was used as a guide in the construction of this map (figure 2). The land class or land classes shown indicate that, in general, they comprise more than 75 percent of the area involved. In addition, no land class was shown that did not comprise at least 15 percent or more of the delineated area. Where more than one land class is shown, the dominant or more extensive land class is indicated first. The small scale of this map precludes the possibility of showing small areas of land with different capabilities for irrigation. For example, the extensive areas of class 6 land may, and often do, contain small acreages of irrigable soils. Nowhere, however, was there as much as 15 percent of the land in another irrigation land class. These small areas, therefore, are not identified.

Table 6. Irrigation land classes for five major soil associations, San Juan County, New Mexico

Soil Map Symbol and Soil Association	Class 1		Class 2		Class 3		Class 4		Total (1–4)		Class 6	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
2 San Mateo-Fruitland-Woodrow	108,695	35	108,690	35	31,055	10	31,055	10	279,495	90	31,055	10
3 Doak-Shiprock			161,075	85			3,790	2	164,865	87	24,635	13
4 Shiprock-Sheppard-Nageesi			105,610	30	70,410	20	140,815	40	316,835	90	35,205	10
15 Del Rio-Caja			18,245	45	16,220	40			34,465	85	6,085	15
16 La Fonda-Del Rio			12,110	50	2,420	10	2,420	10	16,950	70	7,270	30
Total	108,695	12	405,730	44	120,105	13	178,080	20	812,610	89	104,250	11

Interpretation of Soils for Engineering Uses

In this section, information is provided on engineering properties and uses of soils as construction material and as a support for various kinds of structures. The data are in tabular form and grouped by soil associations shown on the small-scale soil map accompanying this report. Selected engineering properties, engineering classifications, and estimates on the suitability of soils for specified engineering uses are indicated for the major soils in each soil association. This correlation of engineering data and soil properties, according to soil associations, can be useful in estimating the suitability of certain areas for engineering purposes. The information on general soil problems, limitations, and hazards can also be helpful in the selection of areas for various engineering structures or practices.

The engineering interpretations in this section will undoubtedly be most useful to engineers and others who have a working knowledge of the principles of soil mechanics and have some familiarity with engineering groupings of soils. The estimated engineering properties and characteristics of the soils presented in this section are based only on a limited number of soil tests, so the information is of a general nature intended primarily for making interpretations useful in broad area planning. It should be emphasized that the engineering interpretations presented here may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where excavations are deeper than the depth of the soil layers here reported. Even in these situations, the soil map is useful for planning more detailed field investiations and for suggesting the kinds of problems that may be expected.

Engineering Soil Groupings and Estimated Soil Properties

Estimates of selected soil properties and engineering soil groupings are given in table 7. In this section, soil texture is described according to the classification used by the U. S. Department of Agriculture, the system approved by the American Association of State Highway Officials (AASHO), and the Unified system established by the Corps of Engineers, U. S. Army.

In the system used by scientists of the U. S. Department of Agriculture, the texture of the soil horizon depends on the proportional amounts of the different sized mineral particles. The percentage of soil material smaller than 2.0 millimeters (classified as clay, silt, and sand) determines the textural classification (column headed "USDA texture").

The AASHO system[9] classifies the soils according to their engineering properties, based on field performance of highways. In this system soil materials are classified in seven basic groups, designated A-1 through A-7. The best soils for road subgrades--gravelly soils of high bearing capacity--are classified as A-1; the next best, A-2: and so on to the poorest, which are classified as A-7 (column headed "AASHO.").

The Unified system[10] is based on the identification of soils according to particle size, plasticity, and liquid limit. In the Unified system SW and SP are clean sands; SM and SC are sands with nonplastic or plastic fines (G will replace S for soils if the major course fraction is gravel); ML and CL are non plastic or plastic fine-grained materials with low liquid limits; and MH and CH are primarily nonplastic or plastic fine-grained materials with high liquid limit. If soils are on the borderline between two classifications, a joint classification symbol is used for example, ML-CL (column headed "Unified").

The estimated soil material passing sieves No. 4, No. 10, and No. 200, in the columns headed by these sieve numbers, reflects the normal range for the given soil series. Although the grain size may vary, most soils within a soil series will fall within the range given.

In the column headed "range in permeability" is the rate that water moves through the undisturbed soil. The rate depends dominantly on texture, structure, and porosity of the soil.

The shrink-swell potential indicates how much a soil changes in volume when its moisture content changes. It is estimated primarily on the basis of the amount and kind of clay the soil contains.

Engineering Interpretations

Table 8 indicates the suitability of soils for specified engineering uses. Also listed are soil features or properties that might present difficulties or affect such use.

Topsoil ratings of good, fair, or poor are given to the surface soil layers that may be used to top-dress road banks, dams, or other structures where establishment of vegetation is desirable. A good rating can be interpreted as a loamy, fertile soil that is easily worked and well suited to top-dress embankments or exposed unfavorable soil materials.

Suitability ratings of good, fair, and poor are indicated for soil material that is to be excavated and used as borrow for highway subgrade. Generally, the best soil material for subgrade and subbase are course-grained soils. The suitability of fine-grained soils ranges from fair to very poor.

The degree of limitation for use of septic tank filter fields was estimated on the basis of permeability rate, depth to bedrock or shale, presence of a clay layer or hardpan, and depth to watertable. The degree of limitation is indicated as severe, moderate, or slight.

The corrosion potential of a soil is determined largely by the nature and amount of soluble salts and by the moisture content. Although it is difficult to correlate the rate of corrosion of such structural material as untreated steel pipe with a single soil property, soils with a relatively high content of salt were generally rated as having a high potential. It was assumed that there would be sufficient moisture for the salts to be active. Other soil features considered were soil drainage, texture, and permeability. The degree of corrosion potential is given as high, moderate, or low.

In the remainder of the columns on table 8 are given the major soil features or properties that affect the use of a soil for specified purpose.

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[9] American Association of State Highway Officials. 1961 Standard Specifications for Highway Materials and Methods of Sampling and Testing. Ed. 8, 2 v., illus.

[10] Waterways Experiment Station, Corps of Engineers. 1953. The Unified Soil Classification System. Tech. Memo. No. 3-357, 2v and appendix. 44 pp., illus.

Table 7. Engineering soil groups and estimated soil properties, San Juan County, New Mexico

Soil Map Symbol and Soil Association	Depth from Surface	Classification			Percentage Passing Sieve			Range in Permeability	Shrink-swell Potential
		USDA texture	Unified	AASHO	No. 4 (4.7mm)	No. 10 (2.0mm)	No. 200 (0.074mm)		
	in.							in/hr	
1 Persayo									
Persayo	0-12	Silty clay loam	CL	A-6 or A-7	100	100	70-90	0.20 - 0.63	Moderate
Moenkopie	0-14	Fine sandy loam	SM	A-4	85-95	80-90	45-60	2.50 - 7.5	Low
Sundown	0-15	Loamy sand	SM	A-3	100	100	15-25	7.50	Low
	15-29	Sand	SP-SM	A-3	100	100	5-15	7.50	Low
	29-49	Gravelly sand	SW	A-3	70-80	60-70	1-10	7.50	Low
	49-60	Sand	SP-SW	A-3	100	100	5-15	7.50	Low
2 San Mateo-Fruitland-Woodrow									
San Mateo	0-7	Loam	ML	A-4	100	100	40-50	0.63 - 2.50	Low
	7-12	Very fine sandy loam	SM	A-2-4	100	100	30-40	0.63 - 2.50	Low
	38-60	Loam	ML or CL	A-4	100	100	80-95	0.63 - 2.50	Low
Fruitland	0-60	Sandy loam	SM	A-2-4 or A-4	100	100	25-50	2.50 - 7.50	Low
Woodrow	0-60	Clay loam	CL or CH	A-7	100	100	70-90	0.20 - 0.63	Moderate to high
Turley	0-60	Clay loam	CL or CH	A-6	100	100	70-90	0.20 - 0.63	Moderate to high
Unnamed 22	0-60	Loam	ML	A-4	100	100	45-75	0.63 - 2.50	Low
3 Doak-Shiprock									
Doak	0-5	Loam	ML	A-4	100	100	60-75	0.63 - 2.50	Low
	5-17	Clay loam	CL	A-6	100	100	75-90	0.63 - 2.50	Moderate
	17-60	Clay loam	CL	A-6	100	100	70-90	0.63 - 2.50	Low
Shiprock	0-4	Fine sandy loam	SM	A-4	100	100	35-50	2.50 - 7.50	Low
	4-13	Sandy clay loam	ML	A-4	100	100	45-55	0.63 - 2.50	Low
	13-60	Fine sandy loam	SM	A-2-4	100	100	25-35	2.50 - 7.50	Low
Unnamed 46	0-39	Loam	ML	A-4	100	100	60-75	0.63 - 2.50	Low
	39-60	Very fine sandy loam	ML	A-4	100	100	45-60	0.63 - 2.50	Low
4 Shiprock-Sheppard-Nageesi									
Shiprock	0-4	Fine sandy loam	SM	A-4	100	100	35-50	2.50 - 7.50	Low
	4-13	Sandy clay loam	ML	A-4	100	100	45-55	0.63 - 2.50	Low
	13-60	Fine sandy loam	SM	A-2-4	100	100	25-35	2.50 - 7.50	Low
Sheppard	0-60	Loamy sand	SM or SP-SM	A-3	100	100	5-20	7.50	Low
Nageesi	0-12	Sandy loam	SM	A-2-4	100	100	25-40	2.50 - 7.50	Low
	12-28	Fine sandy loam	SM	A-4	100	100	35-50	2.50 - 7.50	Low
	28-44	Sandy loam	SM	A-2-4	100	100	25-40	2.50 - 7.50	Low
	44-60	Loamy sand	SM	A-1-6	100	100	10-25	7.50	Low
5 Hilly-Gravelly Land									
Hilly-Gravelly land	Engineering estimates not made								
Doak	0-5	Loam	ML	A-4	100	100	60-75	0.63 - 2.50	Low
	5-17	Clay loam	CL	A-6	100	100	75-90	0.63 - 2.50	Moderate
	17-60	Clay loam	CL	A-6	100	100	70-90	0.63 - 2.50	Low
6 Badland-Rockland-Alluvial Land									
Badland	Engineering estimates not made								
Persayo	0-12	Silty clay loam	CL	A-6 or A-7	100	100	70-90	0.20 - 0.63	Moderate
7 Turley-Badland									
Turley	0-60	Clay loam	CL or CH	A-6	100	100	70-90	0.20 - 0.63	Moderate
Unnamed 22	0-60	Loam	ML	A-4	100	100	45-75	0.63 - 2.50	Low
8 Rockland-Billings									
Billings	0-60	Silty clay loam	CL or ML-CL	A-6 or A-7	100	100	75-90	0.20 - 0.63	Moderate
Christianburg	0-60	Clay	CH	A-7	100	100	75-95	0.2	High
Moenkopie	0-14	Fine sandy loam	SM	A-4	90-95	80-90	45-55	2.50 - 7.5	Low
9 Moenkopie									
Moenkopie	0-14	Fine sandy loam	SM	A-4	90-95	80-90	45-55	2.50 - 7.5	Low
Unnamed 62	0-4	Fine sandy loam	SM	A-4	100	100	45-55	2.50 - 7.5	Low
	4-25	Very fine sandy loam	ML	A-4	100	100	50-75	1.5 - 2.5	Low
Unnamed 63	0-4	Fine sandy loam	SM	A-4	100	100	45-60	2.50 - 7.5	Low
	4-60	Very fine sandy loam	ML	A-4	100	100	50-75	1.5 - 2.5	Low

Persayo	0-12	Silty clay loam	CL	A-6 or A-7	100	100	70-90	0.20 - 0.63	Moderate
Billings silty clay loam	0-60	Silty clay loam	CL or ML-CL	A-6 or A-7	100	100	75-90	0.20 - 0.63	Moderate
Christianburg	0-60	Clay	CH	A-7	100	100	75-95	0.2	High
11 Persayo-Rockland									
Persayo	0-12	Silty clay loam	CL	A-6 or A-7	100	100	70-90	0.20 - 0.63	Moderate
Unnamed 62	0-4	Fine sandy loam	SM	A-4	100	100	45-55	2.50 - 7.5	Low
	4-25	Very fine sandy loam	ML	A-4	100	100	50-75	1.5 - 2.5	Low
12 Chipeta-Sheppard-Shiprock									
Chipeta	0-15	Clay	CH	A-7	100	100	75-90	0.2	High
Sheppard	0-60	Loamy sand	SM or SP-SM	A-3	100	100	5-20	7.5	Low
Shiprock	0-4	Fine sandy loam	SM	A-4	100	100	35-50	2.50 - 7.50	Low
	4-13	Sandy clay loam	ML	A-4	100	100	45-55	0.63 - 2.50	Low
	13-60	Fine sandy loam	SM	A-2-4	100	100	25-35	2.50 - 7.50	Low
13 Rockland-Shallow Soil									
Rockland	Engineering estimates not made								
Unnamed 101	0-4	Gravelly loam	ML	A-4	65-80	50-70	30-50	0.63 - 2.50	Low
	4-7	Loam	ML	A-4	100	100	60-75	0.63 - 2.50	Low
	7-15	Clay loam	CL	A-6	100	100	70-80	0.20 - 0.63	Moderate
14 Travessilla-Rockland									
Travessilla	0-15	Sandy loam	SM	A-4 or A-2-4	90-95	80-90	25-50	2.50 - 7.5	Low
Del Rio	0-7	Loam	ML	A-4	100	100	75-90	0.63 - 2.50	Low
	7-37	Clay loam	CL	A-6	100	100	75-90	0.20 - 0.63	Moderate
	37-60	Clay loam	CL	A-6	100	100	70-85	0.63 - 2.50	Moderate
Unnamed 111	0-15	Silty clay loam	CL	A-6 or A-7	100	100	70-90	0.20 - 0.63	Moderate
15 Del Rio-Caja									
Del Rio	0-7	Loam	ML	A-4	100	100	75-90	0.63 - 2.50	Low
	7-37	Clay loam	CL	A-6	100	100	75-90	0.20 - 0.63	Moderate
	37-60	Clay loam	CL	A-6	100	100	70-85	0.63 - 2.50	Moderate
Caja	0-8	Loam	ML	A-4	100	100	70-90	0.63 - 2.50	Low
	8-30	Silty clay loam	CH or MH	A-7	100	100	75-90	0.20 - 0.63	High
	30-60	Clay loam	CL	A-6	100	100	70-80	0.20 - 0.63	Low
Travessilla	0-15	Sandy loam	SM	A-4 or A-2-4	90-95	80-90	25-50	2.50 - 7.5	Low
16 La Fonda-Del Rio									
La Fonda	0-4	Loam	ML	A-4	100	100	60-75	0.63 - 2.50	Low
	4-16	Heavy loam	ML-CL	A-4	100	100	60-80	0.20 - 2.50	Low-Moderate
	16-60	Loam	ML	A-4	100	100	60-75	0.63 - 2.50	Low
Del Rio	0-7	Loam	ML	A-4	100	100	75-90	0.63 - 2.50	Low
	7-37	Clay loam	CL	A-6	100	100	75-90	0.20 - 0.63	Moderate
	37-60	Clay loam	CL	A-6	100	100	70-85	0.63 - 2.50	Moderate
17 Travessilla-Malposa-Rockland									
Travessilla	0-15	Sandy loam	SM	A-4 or A-2-4	90-95	80-90	25-50	2.50 - 7.5	Low
Malposa	0-5	Stony loam	LM or SM	A-4	60-70	40-60	25-40	0.63 - 2.50	Low
	5-16	Stony clay loam	CL	A-6	70-85	60-70	50-60	0.20 - 0.63	Moderate
	16-30	Stony loam	LM or CL	A-4 or A-6	60-75	40-60	25-40	0.63 - 2.50	Low
18 Mountain Soils									
Unnamed 201	0-11	Loam	LM	A-4	100	100	45-60	0.63 - 2.50	Low
	11-25	Loamy fine sand	SM	A-3	100	100	15-25	7.50	Low
	25-30	Sandy clay loam	LM	A-4 or A-6	100	100	35-60	0.63 - 2.50	Low-Moderate
	30-60	Very fine sandy loam	SM or LM	A-4	100	100	45-60	0.63 - 2.50	Low
Unnamed 202	0-24	Loam	LM	A-4	100	100	60-75	0.63 - 2.50	Low
	24-30	Very fine sandy loam	SM	A-4	100	100	45-60	0.63 - 2.50	Low
	30-36	Sandy clay loam	ML	A-4	100	100	35-50	0.63 - 2.50	Low
	36-60	Very fine sandy loam	SM	A-4	100	100	45-60	0.63 - 2.50	Low
Unnamed 203	0-13	Loam	ML	A-4	100	100	60-75	0.63 - 2.50	Low
	13-20	Very fine sandy loam	ML or SM	A-4	100	100	45-75	0.63 - 2.50	Low

Table 8. Interpretations of engineering properties of soils in San Juan County, New Mexico

Soil Map Symbol and Soil Association	Suitability as a Source of-- Topsoil	Road fill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential	Foundation Support
1 Persayo					
Persayo silty clay loam	Poor; erodible	Poor	Severe; shallow to shale; slow permeability	High	Poor bearing capacity; shallow to shale; low shear
Moenkopie sandy loam	Poor; low fertility; erodible	Fair; material very limited	Severe; shallow to sand-stone	Low	Sandstone at depths of 10 to 20 inches
Sundown (40) loamy sand	Poor; sandy and erodible	Good if soil binder is added	Slight	Low	**
2 San Mateo-Fruitland-Woodrow					
San Mateo loam	Surface 8 to 10 inches good; subsoil fair	Fair	Moderate; overflow and water table may be problems	Moderate	Water table and over-flow may be problems
Fruitland sandy loam	Fair; moderately sandy	Good	Slight	Low	**
Woodrow clay loam	Poor to fair; high clay content	Poor	Severe; slow permeability	Moderate	Low bearing capacity when wet; moderate to high shrink-swell
Turley clay loam	Poor; erodible high clay content	Poor	Severe; slow permeability	Moderate to high	Poor bearing capacity when wet; moderate to high shrink-swell
Unnamed (22) loam	Surface 6 to 10 inches good; subsoil fair	Fair	Moderate	Low to moderate	**
3 Doak-Shiprock					
Doak loam	Fair	Fair	Moderate; permeability moderately slow	Low to moderate	Moderate shrink-swell and bearing capacity when wet
Shiprock fine sandy loam	Poor; sandy and erodible	Good	Slight	Low	**
Unnamed (46) loam	Fair	Fair to good	Moderate; permeability moderate	Moderate	**
4 Shiprock-Sheppard-Nageesi					
Shiprock fine sandy loam	Poor; sandy and erodible	Good	Slight	Low	**
Sheppard loamy sand	Poor; very sandy and erodible	Good if soil binder is added	Slight	Low	All features favorable except under-cutting by wind erosion
Nageesi sandy loam	Poor; sandy and erodible	Good	Slight	Moderate	**
Unnamed (13)	Poor; sandy and erodible	Good if soil binder is added	Slight	Low	**
5 Hilly-Gravelly Land					
Hilly gravelly land	Interpretations not made				
Doak loam	Fair	Fair	Moderate; permeability moderately solw	Low to moderate	Moderate shrink-swell and bearing capacity when wet
Unnamed (46) loam	Fair	Fair to good	Moderate; permeability moderate	Moderate	**

*Unsuitable or practice not applicable
**Soil features favorable

Soil Features Affecting Engineering Practices				
	Farm ponds		Dykes and levees	Sanitary
Highway location	Reservoir	Embankment	(terraces and diversions)	land fills
Shallow to shale; unstable material; very erodible; moderate slopes	Subject to seepage; shallow to shale; saline	Poor stability; subject to cracking	Unstable embankments channels subject to siltation; difficult to vegetate	Shallow to shale
Shallow to sandstone; outcrops of sandstone; moderate slopes	Shallow; subject to seepage	Limited soil material; moderate permeability	*	*
Good; moderately erosive when exposed on embankments	Poor; very rapidly permeable	Erodible and permeable	Erodible; sandy and porous material difficult to vegetate	Sandy and erodible
Occasional high water tables and seep areas	Moderate permeability; sandy stratas may require sealing	Stable material when compacted	**	Water table may limit excavation
**	Rapidly permeable; subject to seepage	Erodible; fair if compacted	Erodible and permeable; fairly stable if compacted	Good; subject to wind erosion
Plastic and low bearing capacity when wet	Good; low permeability	Subject to cracking on drying. Plastic when wet	Subject to cracking on drying. Difficult to vegetate; subject to channel erosion	Difficult to excavate when wet
Plastic material; poor bearing capacity when wet	Good; low permeability	Difficult to work; plastic when wet. Erodible	Erodible; difficult to vegetate; subject to channel erosion	Difficult to excavate when wet
**	Good with compaction	Stable material when compacted	**	**
Moderately plastic and moderate bearing capacity when wet	Good; slowly permeable subsoil	Stable material when compacted	Subsoil material subject to cracking and difficult to vegetate	**
**	Rapidly permeable	Erodible; fair if compacted	Erodible; very permeable	Subject to wind erosion
**	High lime content; requires compaction	Exposed limy material erodible and difficult to vegetate	Exposed limy material erodible and difficult to vegetate	**
**	Rapidly permeable	Erodible; fair if compacted	Erodible; very permeable	Subject to wind erosion
Wind erosion and drifting sand	Material too porous to hold water	Erodible and very permeable	*	Subject of severe wind erosion
**	Rapidly permeable	Erodible; fair if compacted	Erodible; exposed limy difficult to vegetate	Good; subject to wind erosion
Moderately erosive when exposed on embankments	Poor; very rapidly permeable	Erodible and permeable	*	Sandy and erodible
Moderately plastic and moderate bearing capacity when wet	Good; slowly permeable subsoil	Stable material when compacted	Subsoil material subject to cracking and difficult to vegetate	**
**	High lime content; requires compaction	Exposed limy material erodible and difficult to vegetate	Exposed limy material erodible and difficult to vegetate	**

Table 8. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of-- Topsoil	Road fill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential	Foundation support
6 Badland-Rockland-Alluvial Land					
Badland	Poor	Very poor	Severe	High	Poor bearing capacity; low shear
Rockland	Interpretations not made				
Persayo silty clay loam	Poor; erodible	Poor	Severe; shallow to shale; slow permeability	High	Poor bearing capacity; shallow to shale; low shear
7 Turley-Badland					
Turley clay loam	Poor; erodible high clay content	Poor	Severe; slow permeability	Moderate to high	Poor bearing capacity when wet; moderate to high shrink-swell
Unnamed (22) loam	Surface 6 to 10 inches good; subsoil fair	Fair	Moderate	Low	*
8 Rockland-Billings					
Rockland	Interpretations not made				
Billings silty clay loam	Poor; erodible high silt and clay content	Poor	Severe; slow permeability	Moderate to high	Poor bearing capacity; moderate shrink-swell
Christianburg clay	Poor; high clay content	Poor	Severe; very slowly permeable	High	Poor bearing capacity; high shrink-swell potential
Moenkopie fine sandy loam	Poor; low fertility; erodible	Fair; material very limited	Severe; shallow to sandstone	Low	Sandstone at depths of 10 to 20 inches
9 Moenkopie					
Moenkopie sandy loam	Poor; low fertility; erodible	Fair; material very limited	Severe; shallow to sandstone	Low	Sandstone at depths of 10 to 20 inches
Unnamed (62) fine sandy loam	Poor; low fertility; erodible	Fair; borrow material limited	Severe; 20 to 36 inches to sandstone	Low to moderate	Sandstone at depths of 20 to 36 inches
Unnamed (63) fine sandy loam	Poor; low fertility; erodible	Fair	Slight	Low	**
10 Persayo-Billings					
Persayo silty clay loam	Poor; erodible	Poor	Severe; shallow to shale; slow permeability	High	Poor bearing capacity; shallow to shale; low shear
Billings silty clay loam	Poor; erodible high silt and clay content	Poor	Severe; slow permeability	Moderate to high	Poor bearing capacity; moderate shrink-swell
Christianburg clay	Poor; high clay content	Poor	Severe; very slowly permeable	High	Poor bearing capacity; high shrink-swell potential
11 Persayo-Rockland					
Persayo silty clay loam	Poor; erodible	Poor	Severe; shallow to shale; slow permeability	High	Poor bearing capacity; shallow to shale; low shear
Unnamed (62) fine sandy loam	Poor; low fertility; erodible	Fair; borrow material limited	Severe; 20 to 36 inches to sandstone	Low to moderate	Sandstone at depths of 20 to 36 inches
Rockland	Interpretations not made				
12 Chipeta-Sheppard-Shiprock					
Chipeta clay	Poor; high clay content; erodible	Poor	Severe; shallow to shale; low permeability	High	Poor bearing capacity; low sheer; high shrink-swell
Sheppard loamy sand	Poor; very sandy and erodible	Good if soil binder is added	Slight	Low	All features favorable except under-cutting by wind erosion
Shiprock fine sandy loam	Poor; sandy and erodible	Good	Slight	Low	**

Soil Features Affecting Engineering Practices				
	Farm ponds		Dykes and levees	Sanitary
Highway location	Reservoir	Embankment	(terraces and diversions)	land fills
Very poor; very shallow to shale; erodible; steep slopes	Subject to seepage; saline; very shallow	Poor stability erodible; saline	*	Difficult to excavate when wet
Shallow to shale; unstable material; very erodible; moderate slopes	Subject to seepage; shallow to shale; saline	Poor stability; subject to cracking	Unstable embankments channels subject to siltation; difficult to vegetate	Shallow to shale
Plastic material; poor bearing capacity when wet	Good; low permeability	Difficult to work; plastic when wet; erodible	Erodible; difficult to vegetate; subject to channel erosion	Difficult to excavate when wet
**	Good with compaction	Stable material when compacted	**	**
Poor stability and bearing value	Cracks when dry; may need compaction	Poor stability; erodible	Subject to cracking on drying; low stability; erodible; subject to channel erosion	Moderately difficult to excavate when wet;erodible
Poor stability and bearing value; high shrink-swell	Good; very slowly permeable	Poor stability; erodible	Subject to cracking on drying; poor stability; erodible; subject to channel erosion and piping	Very difficult to excavate when wet
Shallow to sandstone; outcrops of sandstone; moderate slopes	Shallow to sandstone; subject to seepage	Limited soil material; moderate permeability	*	*
Shallow to sandstone; outcrops of sandstone; moderate slopes	Shallow to sandstone; subject to seepage	Limited soil material; moderate permeability	*	*
Good stability and bearing value	Subject to seepage; moderately deep to sandstone	Erodible; moderate permeability	Erodible; fair stability if compacted	Moderately deep to sandstone
**	Subject to seepage; may require compacting and sealing	Erodible; moderate permeability	Erodible; fair if compacted	Good; subject to wind erosion
Shallow to shale; unstable material; very erodible; moderate slopes	Subject to seepage; shallow to shale; saline	Poor stability; subject to cracking	Unstable embankments channels subject to siltation; difficult to vegetate	Shallow to shale
Poor stability and bearing value	Cracks when dry; may need compaction	Poor stability; erodible	Subject to cracking on drying; low stability; erodible; subject to channel erosion	Moderately difficult to excavate when wet;erodible
Poor stability and bearing value; high shrink-swell	Good; very slowly permeable	Poor stability; erodible	Subject to cracking on drying; poor stability; erodible; subject to channel erosion and piping	Very difficult to excavate when wet
Shallow to shale; unstable material; very erodible; moderate slopes	Subject to seepage; shallow to shale; saline	Poor stability; subject to cracking	Unstable embankments channels subject to siltation; difficult to vegetate	Shallow to shale
Good stability and bearing value	Subject to seepage; moderately deep to sandstone	Erodible; moderate permeability	Erodible; fair stability if compacted	Moderately deep to sandstone
Shallow to shale; poor stability and bearing capacity; high shrink-swell	Subject to seepage; very shallow to shale; saline	Poor stability; erodible saline	*	Shallow to shale; difficult to excavate
Wind erosion and drifting sand	Material to porous to hold water	Erodible and very permeable	*	Subject of severe wind erosion
**	Rapidly permeable	Erodible; fair if compacted	Erodible; very permeable	Subject to wind erosion

Table 8. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of-- Topsoil	Road fill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential	Foundation support
13 Rockland-Shallow Soil					
Unnamed (101) gravelly loam	Poor; low fertility; gravelly	Fair; borrow material limited	Severe; shallow to bedrock	Moderate	Bedrock at 10 to 20 inches
Rockland	Interpretations not made				
14 Travessilla-Rockland					
Travessilla sandy loam	Poor; sandstone fragments; erodible	Fair; borrow material limited	Severe; shallow to sandstone	Low	Sandstone bedrock at depths of 10 to 20 inches
Del Rio loam	Good to a depth of 6 to 10 inches	Poor	Severe; low permeability	Moderate	Fair bearing capacity and shear strength; moderate shrink-swell
Unnamed (111) silty clay loam	Poor; high silt and clay content; erodible	Poor; borrow material limited	Severe; shallow to shale	High	Poor bearing capacity and shear strength; shallow to shale
Rockland	Interpretations not made				
15 Del Rio-Caja					
Del Rio loam	Good to a depth of 6 to 10 inches	Poor	Severe; low permeability	Moderate	Fair bearing capacity and shear strength; moderate shrink-swell
Caja loam	Good to a depth of 6 to 8 inches	Poor	Severe; low permeability	Moderate	Poor to fair bearing capacity and shear strength; moderate shrink-swell
Travessilla sandy loam	Poor; sandstone fragments; erodible	Fair; borrow material limited	Severe; shallow to sandstone	Low	Sandstone bedrock at depths of 10 to 20 inches
16 La Fonda-Del Rio					
La Fonda loam	Fair to a depth of 6 to 8 inches	Fair	Moderate; moderate permeability	Low to moderate	Fair bearing capacity and shear strength
Del Rio loam	Good to a depth of 6 to 10 inches	Poor	Severe; low permeability	Moderate	Fair bearing capacity and shear strength; moderate shrink-swell
17 Travessilla-Malposa-Rockland					
Travessilla sandy loam	Poor; sandstone fragments; erodible	Fair; borrow material limited	Severe; shallow to sandstone	Low	Sandstone bedrock at depths of 10 to 20 inches
Malposa stony loam	Poor; stony	Poor	Severe; shale and sandstone often within 5 feet	Moderate to high	May be subject to slides because of underlying shale and sandstone; fair bearing value
Rockland	Interpretations not made				
18 Mountain Soils					
Unnamed (201) loam	Good to a depth of 10 to 15 inches	Fair	Slight; soil features favorable	Low to moderate	Soil features favorable; steep slopes
Unnamed (202) loam	Good to a depth of 20 to 24 inches	Fair	Moderate; moderately permeable; deep to sandstone	Low to moderate	Fair to good bearing capacity
Unnamed (203) loam	Fair; some sandstone fragments; limited depth	Fair; borrow material limited	Severe; shallow to sandstone	Low to moderate	Shallow to sandstone

*Unsuitable or practice not applicable
**Soil features favorable

Soil Features Affecting Engineering Practices				
	Farm ponds			
Highway location	Reservoir	Embankment	Dykes and levees (terraces and diversions)	Sanitary land fills
Shallow to bedrock	Subject to seepage; shallow to bedrock	Limited soil material; shallow to bedrock	*	*
Shallow to sandstone; outcrops of bedrock slope	Subject to seepage through fractured sandstone	Limited soil material; erodible	*	*
Fair stability and bearing value	Good; slowly permeable	Fair stability; impervious	Fairly stable; impervious	**
Poor stability and bearing capacity; shallow to shale	Subject to seepage; shallow to shale	Limited fill material: erodible	Unstable embankments; subject to channel erosion and siltation	Shallow to shale
Fair stability and bearing value	Good; slowly permeable	Fair stability; impervious	Fairly stable; impervious	**
Fair stability and poor to fair bearing value	Good; slowly permeable	Fair stability; clayey impervious material	Fairly stable; subject to moderate cracking on drying	Difficult to excavate when wet
Shallow to sandstone; outcrops of bedrock slope	Subject to seepage through fractured sandstone	Limited soil material; erodible	*	*
Erodible; embankment materials; fair bearing value	Moderate permeability; good if compacted	Fair stability; subject to moderate channel erosion	Fairly stable; moderately permeable	**
Fair stability and bearing value	Good; slowly permeable	Fair stability; impervious	Fairly stable; impervious	**
Shallow to sandstone; outcrops of bedrock slope	Subject to seepage through fractured sandstone	Limited soil material; erodible	*	*
Steep slopes; stony; shale and sandstone often within 5 feet; rock outcrops	*	*	*	Steep slopes; stony; shale and sandstone often within 5 feet
Steep slopes; some stones and rock outcrops; fair stability and bearing capacity	Moderate permeability; good if compacted	Good stability	*	Steep slopes; some stones
Surface layers have moderate organic matter; few outcrops of bedrock; few seep areas	Moderate permeability; good if compacted	Good stability	**	**
Moderate slopes; shallow to sandstone; occasional outcrops of bedrock	Shallow; subject to seepage	Borrow material limited; good stability	*	*

Summary

The general soil map for San Juan County provided the basis for estimating the amount of land in the county that is suitable for irrigation. This is a small-scale map on which are outlined the general soil areas or soil associations within the county. It represents a rather broad generalization and is not useful for farm planning or other types of detailed planning. It can be used for community planning, for making predictions relative to the development of soil resources for large areas, and for various types of broad area planning.

Approximately 38 percent of the soils in the county are suitable for use as cropland under irrigation. The irrigable land, however, is widely distributed and frequently occurs in small tracts which will tend to limit its use for irrigation. Soil associations 3 and 4 contain relatively large acreages of irrigable soils that are frequently in large tracts. Soil association 2 also has a sizeable acreage of irrigable soils, but unlike soil associations 3 and 4, the irrigable lands are widely distributed and often occur in small tracts. In addition to soils and water supplies, the small size and wide distribution of many of the areas suitable for irrigation will undoubtedly have a major influence on the expansion of irrigated land in this county.

The soils have been classified in the AASHO and the Unified systems to facilitate use of the soil association information by engineers and others acquainted with these groupings. The suitability of these soils for a variety of uses and the specific factors limiting their use are also described in the engineering section. Because the soils differ greatly from one another, their suitability for specific uses varies greatly. For example, suitability for use as topsoil ranges from poor to fair, and suitability for road fill ranges from very poor to good.

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